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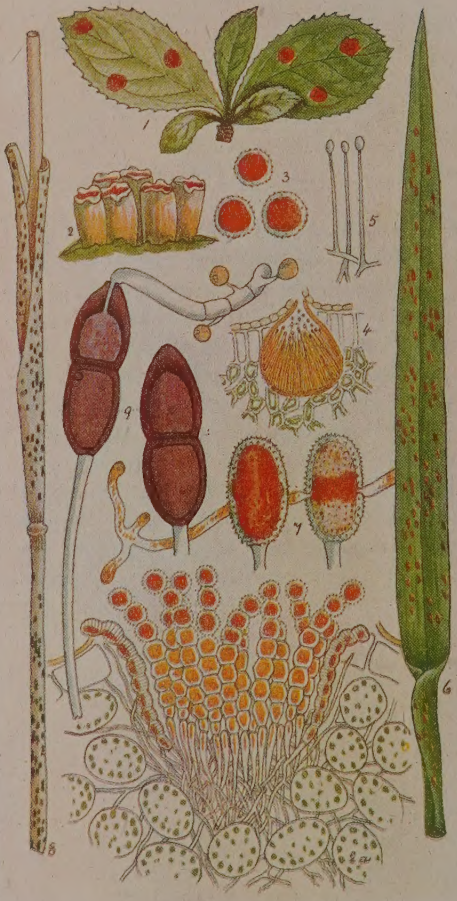
MILDEWS, RUSTS AND SMUTS

THE object of this book is two-fold. All the fungi described are parasitic on living plants, and include many that are amongst the most serious pests with which the cultivator of plants has to contend. One object of the book is to enable those interested in this branch of mycology to determine accurately the cause of injury, the first step towards a remedy.

Secondly, although many books dealing with fungi have appeared of late, yet the important Families dealt with in this book have been persistently ignored, and the study of fungi has been revolutionised since the latest account of these families appeared in this country.


1
2
3
4
5
6
7
8
9

FRONTISPIECE

Fig.

1. *Puccinia graminis*, Pers., aecidial stage on leaves of barberry; nat. size.
2. A cluster of aecidia or "cluster cups"; the cups are too long in the fig.; mag.
2a. Section of an aecidium, showing the spores produced in basipetal chains, that is, with the youngest spores at the base of the chain; mag.
3. Aecidiospores; mag.
4. Section of pycnidium or spermogonium; mag.
5. Spermatia from pycnidium; mag.
6. Uredo stage on wheat leaf; nat. size.
7. Uredospores, one germinating; mag.
8. Teleutospore form on dry wheat culm; nat. size.
9. Teleutospores, one germinating and producing a promycelium bearing three secondary spores; mag.

FRONTISPIECE

1. Fig.
2. Uredine pycnidia, Peri. medial stage on leaves of barberry; nat. size.
3. A cluster of aecidia or "cluster cups"; the cups are too long in the fig.; mag.
4a. Section of an aecidium, showing the spores produced on basipetal chains, that is, with the youngest spores at the base of the chain; mag.
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10. Teleutospores, one germinating and producing a promycelium bearing three secondary spores; mag.

MILDEWS RUSTS AND SMUTS

A synopsis of the families, Peronosporaceae Erysiphaceae, Uredinaceae and Ustilaginaceae

BY

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PREFACE

Notwithstanding the considerable number of books dealing with mycology that have appeared in this country during recent years, curiously enough not one of that number has contained a reference to those groups of fungi dealt with in the present volume. The reason is perhaps not far to seek. All the species dealt with come under the category of "microscopic fungi," and as such, are ignored by those mycologists who consider that fungi are only to be met with during the months of September and October. On the other hand, to those who can advance a step beyond the mere learning of names, and the compilation of lists of doubtful value, the study of microscopic fungi affords an insight to the origin and nature of fungi, which cannot be derived from a study of the higher forms alone.

The mildews—Peronosporaceae, illustrate the transition from primitive aquatic fungi to aerial forms, also the origin and development of parasitism. The rusts—Uredinaceae, illustrate that remarkable phenomenon known as heteroecism, which implies that a given fungus lives on two different host-plants during different periods of its life-cycle, the phase on each host-plant respectively starting from a spore or reproductive body. The great charm in connexion with the study of these lower forms lies in the fact that by means of infection experiments and pure cultures, much insight can be gained bearing on the life-history of these minute organisms. All the species are parasites, and unfortunately in too many instances prove destructive to cultivated plants; hence from this standpoint a thorough knowledge of their nature is imperative.

As additions to the Fungus-flora of this country are constantly being recorded, more especially amongst the microscopic forms, it has been considered advisable to include those species not yet met with in Britain, but which are parasitic on host-plants indigenous to this country; also those parasitic on cultivated plants.

GEO. MASSEE.

Kew. IVY MASSEE.

CONTENTS

PAGE

INTRODUCTION 1

Nature of fungi dealt with. Loss caused by parasitic fungi attacking cultivated plants. Progress of the study of mycology since the publication of the last book in this country. Fungi as microscopic objects.

PERONOSPORACEAE 3

Examples of primitive types of aquatic fungi. Sexuality dies out as members become accustomed to living on dry land. Description of sexual reproductive organs. Notes on the leading features of genera. Key to the genera of the family. Systematic description of the species.

ERYSIPHACEAE 35

General characteristics of the family. Naked eye appearance of the species. Known as powdery mildews. Connexion between the two conditions of the species proved. The correct determination of species. Key to the genera. Notes on the genera. Systematic description of the species.

PERISPORIACEAE 49

Affinities of the family. Essentially a tropical family. The one European destructive member. Fungi feeding on "honey-dew." Description of the species.

UREDINACEAE 52

General character of the family. Parasitic nature of all the members. Injury caused to cultivated plants belonging to this family known from early times. Popular versus scientific conception as to what constitutes a fungus. How fungi gain an entrance into the tissues of the plant they infect. Description of the various stages constituting the complete life cycle of a fungus belonging to the Uredinaceae. Saccardo's arrangement of the species included in the genus *Puccinia*. Infection experiments. Biological species. Heteroecism. Parasitism. Definition of the family. Notes on the genera. Systematic description of the species.

USTILAGINACEAE 184

Popularly known as "smuts" on account of the sooty masses of spores. Injury caused to cultivated plants. Mode of spore formation. How distinguished from the Uredinaceae. Key to the genera. Notes on the genera. Systematic description of the species.

MILDEWS, RUSTS AND SMUTS

INTRODUCTION

THE fungi dealt with in this volume are popularly known as "rusts" and "mildews." From an economic standpoint they are of considerable importance, being the direct cause of a loss to cultivated plants throughout the world, of an annual sum amounting to many millions of pounds sterling. Much of this loss can be averted by the timely application of proper preventive methods, but this can only be successfully accomplished by a person possessing a clear knowledge of the particular fungus causing the disease, hence the study of fungi is imperative on the part of all who aspire to the position of what is commonly termed a plant pathologist, or student of economic mycology. The reasons for the possession of this special knowledge are various; the full life-cycle or course of development are in many instances so complicated, that the detection of a vulnerable point in such development can only be discovered by those who have made a special study of the whole course of development of these parasites. All the rusts and mildews are microscopic in size, and their reproductive bodies are so infinitesimally minute, that they are readily dispersed wholesale, and over large areas by wind, birds, insects, etc., hence extermination is an impossibility, and only a full knowledge of the habits and mode of life of such parasites can enable a person to anticipate their advent, and to formulate proper precautions against the outbreak of an epidemic of disease. Finally, all rusts and mildews are parasitic on living plants, more especially on wild plants, and it is generally from wild plants that the parasitic fungus in the first instance passes on to cultivated plants that are botanically related to wild ones.

It is now nearly half a century since the last British book on Fungi, including the rusts and mildews, was published. At that date economic mycology, or the true

connexion between fungi and plant diseases, was practically unknown, as indeed, were the life histories of most of the fungi now dealt with. An extensive index of host-plants has been prepared, as I consider that such an index is of great value—if not abused. The time was when most of the fungi dealt with in this book were named from the host-plant on which they were parasitic, and it was assumed that each host-plant had its own particular parasitic fungus. This idea has not proved to be correct, and it has been shown, by means of infection experiments, that in many instances the same fungus is parasitic on different host-plants. Carefully conducted infection experiments, described later, will undoubtedly demonstrate that certain fungi supposed to be confined to one particular kind of host-plant, are capable of growing on different plants.

To the microscopist in search of beautiful and interesting objects, requiring no very special skill in their preparation, the fungi here described can be recommended.

PERONOSPORACEAE

The members of the present family are primitive types, and illustrate the earliest attempt on the part of fungi to depart from their original aquatic habitat, and establish themselves on dry land. Purely aquatic fungi usually possess sexual organs of functional value, and lack the reproductive bodies known as conidia, so characteristic of terrestrial fungi. The ultimate reproductive bodies produced by aquatic fungi are called zoospores, because they possess the power of spontaneous movement, brought about by the presence of cilia, or very slender prolongations of the body of the spore, the movements of which enable the zoospore to swim in water. Now this method of spore dispersion was quite effective so long as fungi lived in water, but when they essayed to live on dry land, the possession of zoospores alone restricted them to damp localities where water was present in sufficient quantity to enable the zoospores to migrate from one place to another. This difficulty was by degrees overcome by the terrestrial fungi evolving a second form of reproductive bodies called conidia, suitable for being dispersed by wind. It was this second mode of reproduction that enabled fungi to spread over the entire earth's surface. At the present day the primitive mode of sexual reproduction has almost entirely disappeared in the terrestrial fungi, and its place taken by the conidial form of reproduction. Such is the case, for instance, in the large section of fungi known as the Basidiomycetes, which includes the many thousands of gill-bearing fungi, the Polypores or bracket-fungi, etc.

The members of the Peronosporaceae occupy an intermediate or transition position between aquatic and terrestrial fungi. In some species zoospores alone are present, in others the sexual form of reproduction gives origin to zoospores, while the conidial condition produces conidia suitable for dispersion by wind, and germinate by the protrusion of a germ-tube of hypha, which is capable of directly infecting a suitable host-plant. *Phytophthora infestans*, the cause of the much dreaded potato disease, is interesting in this respect, the conidia sometimes giving origin to zoospores, at other times germinating by a germ-tube or branch of mycelium.

In most of the Peronosporaceae the sexual organs are

borne on mycelium buried in the matrix or substance on which the fungus is growing. The sexual organs are well differentiated in both function and size. The *antheridium* or male organ is usually much smaller than the *oogonium* or female organ. In many instances the oogonium commences as the much swollen tip of a hypha, which increases in size until it becomes spherical ; the antheridium appears as a more or less club-shaped branch, springing from the hypha bearing the oogonium and just below it. When oogonium and antheridium are replete with protoplasm, each is cut off by a transverse septum from the parent hypha. The greater portion of the protoplasm in the oogonium then contracts and forms a sphere called the *oosphere*. The antheridium now comes into contact with the wall of the oogonium, and at the point of contact emits a *fertilisation-tube* or slender outgrowth which pierces the wall of the oogonium, and increases in length until it reaches the oosphere. Through this tube the nucleus and a portion of the protoplasm of the antheridium passes into the oosphere and blends with the protoplasm of the latter. The nucleus of the oosphere and of the antheridium now coalesce—the act of fertilisation. After this process of fertilisation the oosphere is termed the *oospore*, and undergoes further changes, and finally develops a firm cell-wall of its own, within the wall of the oogonium. Usually after a period of rest the oospore germinates.

Sometimes oogonia are produced interstitially, or in the length of a hypha except at the tip, and the antheridia may grow on the same hypha as the oogonia, or the antheridia may be borne on an adjacent independent hypha.

With the exception of the genus *Pythium*, conidial forms of reproduction are highly developed in the Peronosporaceae, and in many instances form the most beautiful of microscopic objects met with in the vegetable kingdom. Many of the diseases popularly called mildews, are caused by the conidial stage of members of the present family.

PERONOSPORACEAE

Conidial reproduction by conidia producing zoospores, which germinate at once on coming to rest, or the conidia develop a germ-tube capable of infecting a host-plant. Sexual reproduction by oogonia and antheridia.

NOTES ON THE GENERA

PYTHIUM

The exceedingly minute organisms constituting this genus are remarkable for their lack of differentiation between the vegetative and reproductive portions. A more or less vaguely branched mycelium traverses the host, and here and there throughout its length produces at the tips of branches, or intercalary—that is at intervals in the length of a hypha, the various reproductive bodies. All the species are aquatic, or grow in very damp places, where the zoospores can disperse in a film of moisture. Some are destructive parasites, often attacking plants in the seedling stage, and causing the injury known as "damping off."

CYSTOPUS

The conidial condition of all the species form white, flattened, or slightly raised patches of variable size, on living leaves. The patches are at first white, and present a polished appearance, but finally become powdery when the chains of conidia rupture the epidermis of the leaf. The oospores are formed in the tissues of the leaf, and can only be seen when sections of the diseased parts are prepared. *C. candidus* is very abundant on the weed called Shepherds' purse, which, under the influence of the parasite, usually becomes much twisted and distorted.

PHYTOPHTHORA

Most of the species are destructive parasites to cultivated plants, the most important being *P. infestans*, the cause of the too well known potato disease. All the species form a very delicate white, or greyish, mould on the leaves or stem of the host-plant. The haustoria are not so short, and vesicular or pear-shaped as in allied genera, but grow out like ordinary threads of mycelium, and are more or less elongated. The oospore is smooth in *P. omnivora*, the only species in which it has been observed.

BASIDIOPHORA

There is only one species in this genus, which is readily recognised by the simple, stout conidiophores, swollen at the tip, the swollen portion bearing a number of very short, stout outgrowths, each of which supports a single large conidium. The wall of the oosphere is very thick and hard.

SCLEROSPORA

Agreeing with *Basidiophora* in the oosphere being provided with a very thick wall, but distinguished by the stout, short conidiophores bearing several stout branches near the tip, from which the conidia originate.

S. graminis has been recorded as proving destructive to Indian corn, attacking the inflorescence and seed.

PLASMOPARA

Forming more or less effused, delicate white patches, generally on living leaves, and mostly on the under surface; the portions on the upper surface of the leaf, corresponding to the diseased patches on the under surface, are at first yellowish-green, then brown and dead. The conidiophores are more or less branched, and are more persistent than in some other genera. The wall of the oosphere is exceptionally thick. Some are very destructive parasites on cultivated plants.

BREMIA

The single species included in this genus is readily distinguished by the very remarkable structure of the tips of the ultimate branchlets of the conidiophores, which are expanded into a more or less saucer-shaped structure, having four or five projections situated at intervals along the edge, each of which bears a conidium.

The fungus often proves very destructive to lettuce, especially when grown under glass, the leaves become more or less covered on the under surface with an exceedingly delicate white mould, turn yellow, and die, the whole plant being stunted in growth. Chicory and artichokes are sometimes also severely attacked, as are also cultivated Cinerarias.

PERONOSPORA

Distinguished by the structure of the conidiophores, which emerge through the stomata, usually in small tufts. There is a fairly long, unbranched stem, which near the tip becomes branched by repeated forking in pairs; the upper branchlets are frequently curved, the ultimate ones, which bear the conidia, taper to a point. The conidia are blunt and broadly rounded at the tip. *Plasmopara* most nearly approaches the present genus, but differs in the branching not being regularly forked in pairs, and in the tip of the

conidium being furnished with a wart or papilla. Finally the conidia in *Peronospora* produce a thread-like hypha, or germ-tube on germination, whereas in *Plasmopara*, the conidia produce zoospores on germination.

KEY TO THE GENERA

A. Planoblastae

Conidial or asexual mode of reproduction gives origin to zoospores on germination.

* Hyphae bearing conidia and sporangia, not clearly differentiated from the vegetative mycelium. *Pythium.*

** Conidiophores short, but differentiated from the vegetative mycelium. Conidia in chains . . . *Cystopus.*

*** Conidiophores aerial, sharply differentiated from the vegetative mycelium.

† Conidiophores simple (= unbranched). Tip of conidiophore swollen and studded with a number of short processes, each of which bears a conidium. *Basidiophora.*

†† Conidiophores more or less branched. Conidia emerging through the stomata, elongated, simple or sparingly branched, upper portion with knots or swellings at intervals . . . . . *Phytophthora.*
Conidiophores short, stout, with a few short branches, soon collapsing . . . . . *Sclerospora.*

‡ Conidiophores elongated, much branched upwards, persistent . . . . . *Plasmopara.*

B. Siphoblastae

The asexual fruit, or conidia emit a thread-like mycelium or germ-tube on germination.

Conidiophores much branched, tips of the ultimate branchlets flattened into a saucer-shaped body, having a number of short projections on the edge, each of which bears a conidium . . . . . *Bremia.*

Conidiophores much branched, the tips of the ultimate branchlets pointed, and bearing a conidium *Peronospora.*

PYTHIUM, Pringsheim

Mycelium simple or branched, colourless, zoosporangia terminal or interstitial, formed from the protoplasm and becoming furnished with a very delicate cell-wall, zoospores escaping through the ruptured wall, naked, that is, not protected by a cell-wall; oosphere containing only one

oospore. Antheridia slender, originating below the oosphere.

Differs from all other genera in the vegetative and reproductive mycelium not being differentiated. Some species are destructive parasites.

Pythium debaryanum, Hesse; Massee, *Brit. Fung.*, p. 133.

Mycelium vaguely branched, sometimes with an occasional septum, colourless; zoosporangia globose or broadly elliptical, terminal or intercalary, with an indication of a wart or papilla at the tip, producing zoospores; chlamydospores resembling the zoosporangia, but with thicker walls; oospheres globose, wall not perforated, 21—25 μ, solitary in the oosphere, globose, 15—18 μ, wall thick, smooth, colourless, on germination producing a germ-tube, and not zoospores. Fruit produced outside the host.

Syn. *Pythium equiseti,* Sadebeck.
Pythium vexans, De Bary.
Pythium autumnale, Sadebeck.
Saprolegnia schachtii, Frank.

Parasitic on a great number of different kinds of plants, more especially during the seedling condition, where it is the cause of the disease known as "damping off" of seedlings. Amongst its hosts are *Camelina sativa, Lepidium, Sinapis, Capsella, Beta, Trifolium repens, Spergula arvensis, Zea mays, Panicum miliaceum*; amongst cryptogams may be mentioned the prothallus of *Equisetum autumnale, L. cernuum,* and *L. annotinum*; prothallia of *Todea* and *Polypodium,* amongst ferns; prothallus of *Lycopodium inundatum*; *Pellia epiphylla* and *Plagiochila asplenioides.*

Germany, France and United States.

Pythium proliferum, De Bary; Massee, *Brit. Fung.*, p. 134.

Mycelium usually copiously branched; zoosporangia terminal on short branchlets, egg-shaped or lemon-shaped, with a wart at the tip, zoospores kidney-shaped, with two cilia, escaping through the deliquescent wart, a second zoosporangium often developed within the first empty one; oospheres mostly produced in the substance of the host, globose, 18—24 μ; antheridia, 1—3, mostly 2; oospore only one in an oosphere, smooth, 15—18 μ, germinating by the protrusion of a germ-tube.

Saprophytic on dead insects, flies, mealworms, etc., in water, also on decaying plants.

Germany.

Pythium cytosiphon, Linstedt ; Massee, *Brit. Fung.*, p. 134.

Mycelium rambling amongst the tissues of the host, slender, branched, with an occasional septum ; zoosporangia formed in the peripheral cells, globose to cylindrical, 20 μ diam., up to 240 μ long ; zoospores somewhat kidney-shaped, biciliate, 8—16 μ ; oospheres terminal or intercalary, globose ; oospores singly in the oospheres, globose, with a thick, spiny wall ; antheridia one to each oosphere. Germination unknown.

Syn. *Cytosiphon pythioides*, Roze and Cornu.

Parasitic in the tissues of *Lemna minor, L. gibba, L. arrhiza* (=*Wolffia arrhiza*), and *Riccia fluitans*.

Germany.

Pythium megalacanthum, De Bary ; Massee, *Brit. Fung.*, p. 135.

Mycelium branched, branches tapering, without septa ; zoosporangia mostly formed in the epidermal cells of the host, or some outside the host, globose, cylindrical or oval, often with several beaks, zoospores 12—15 in a sporangium, large, 18—20 μ, biciliate ; oospheres terminal or intercalary, smooth then spiny, 35—45 μ ; oospores globose, smooth, 27 μ.

Parasitic on decaying plants in water.

Germany.

Pythium artotrogus, De Bary.

Mycelium parasitic in the tissues of dead plants ; zoosporangia and chlamydospores unknown ; oospheres formed in the tissues and also on hyphae on the surface of the matrix, globose, mostly intercalary, wall spinulose, 18—27 μ, diam., spines 3—6 μ long ; antheridia cylindrical ; oospore globose with a smooth, yellow wall ; germination, after a period of three or four months, by the protrusion of germ-tubes.

Syn. *Artotrogus hydnosporus*, Montague.
Pythium micracanthium, De Bary.

Occurring in decaying plant tissues, often in company with other species, as in diseased potatoes along with *Phytophthora infestans*, the cause of the well-known potato

disease, and the oospores have been erroneously considered as belonging to the last-named fungus.

CYSTOPUS, Lév.

Mycelium branched, running between the cells of the host-plant, and giving off small vesicular haustoria that penetrate the cells; conidiophores simple, blunt, in dense clusters, each bearing at its tip a single chain of conidia; conidia either all alike in form, and all producing zoospores, or the terminal conidium with a thicker membrane, sterile, or germinating by the emission of a germ-tube, the remainder of the conidia producing zoospores; the sori or clusters of conidia remain covered by the epidermis until the conidia are mature, when they burst through; oogonium globose, wall thin; antheridium club-shaped; oospores globose, wall coloured, usually netted or warted.

The oospores are formed in the tissues of the host-plant, and germinate the following season, producing zoospores.

The genus is called *Albugo* by some authors.

KEY TO THE SPECIES

* *Terminal conidium not differing from the rest in shape or size.*

† *Wall of conidia everywhere of equal thickness.*

candidus, Parasitic on cruciferous plants.

[*brasiliensis*, Speg. Conidia compressed, front view 20 μ, side view 10—14 μ. Parasitic on Composite plants.]

[*euphorbiae*, Cke. and Mass. Conidia minutely warted. On Euphorbiaceous plants.]

[*tropicus*, Lagerh. Conidia subglobose, 18—20 μ; oospore, with large, flattened warts. Parasitic on Piperaceous plants.]

†† *Wall of conidia with a thickened equatorial zone.*

[*convolvulacearum*, Speg. Conidia cuboid, 16—20 × 12—15 μ. Parasitic on Convolvulaceous plants.]

[*solivae*, Schroet. Conidia subglobose, 20—22 × 18—20 μ; wall of oospore minutely netted. Parasitic on Composite plants.]

** *Terminal conidium differing from the rest in shape or size or both.*

† *Wall of conidia everywhere of equal thickness.*

portulacae. Oospore wall netted, with a wart in the centre of each mesh of network. Parasitic on plants belonging to the order Chenopodiaceae.

lepigoni. Oospore wall minutely warted. Parasitic on plants belonging to the order Caryophyllaceae.

[*tilleae*. Conidia globose-ovoid 20—24 × 20—21 μ, terminal one larger and with a thicker wall. Parasitic on plants belonging to the order Crassulaceae.]

[*bliti*. Wall of oospore with a rather large network.]

tragapogonis. Wall of oospore with a vague network and spinulose warts. Parasitic on Composite plants.

Cystopus candidus, Lév. Sori snow-white or faintly tinged yellow, size variable, often forming large patches; conidiophores somewhat club-shaped, conidia all alike in shape, white, subglobose, 10—18 μ diam.; oospores globose, yellowish brown or sometimes dark brown, coarsely warted, the warts sometimes running into irregular, wavy ridges, 30—50 μ diam.

A destructive parasite, most abundant on the weed called Shepherds' purse (*Capsella bursa-pastoris*), but attacking nearly all plants belonging to the order Cruciferae; also attacks the Caper (*Capparis spinosa*), and species of *Alisma*.

The snow-white patches of the fungus are very conspicuous on the leaves, flowers and fruit of the Shepherds' purse, the plant being usually much distorted. Among plants of economic importance, attacked by this fungus, are Horse-radish (*Cochlearia armoracia*); radish (*Raphanus raphanistrum*); cress (*Lepidium sativum*) wall-flower (*Chieranthus cheiri*).

Infection only occurs during the seedling stage of the host, hence the disease does not spread amongst older plants. The conidia on germination produce zoospores, which eventually germinate and enter into the tissues of seedlings through the stomata.

The oospores are formed in the tissues of the host-plant, and after passing the winter in a resting condition, liberate enormous quantities of zoospores, which attack seedlings.

The "Kerguelen's Land Cabbage" (*Pringlea antiscorbutica*) although exempt from the fungus in its native land, could not be kept in cultivation at Kew, owing to the attacks of this parasite.

[Var. **convolvuli,** Berk. Differs from the typical form in having cuboid instead of subglobose conidia.

Syn. *Cystopus convolvulacearum*, Otth.

Parasitic on various species of *Convolvulus* in S. Africa and the United States.]

May possibly prove to be a form of *C. tragopogonis.*

Cystopus portulacae, Lév. Sori white or slightly tinged yellow, form and size variable, rounded or wavy, irregularly scattered; sporophores somewhat club-shaped; conidia of two forms, the terminal one larger than the rest, wall thick, yellowish, base often depressed or umbilicate, sterile or producing mycelium on germination, 20—22 μ diam., the remainder broadly cylindrical, or somewhat variable in shape, colourless, 14—17 × 12—14 μ, producing lenticular zoospores on germination; oospores globose, wall regularly netted, usually with a wart in the centre of each mesh, yellow or yellowish brown, 45—60 μ diam.

Parasitic on the leaves of *Portulaca oleracea* and *P. sativa.*

Cystopus lepigoni, De Bary. Sori usually in small, scattered patches, yellowish; conidia of two kinds, the terminal one larger than the remainder, globose, thick walled, colourless or tinged brown, sterile, 27—30 μ diam., the remainder globose or broadly elliptical, wall thin, colourless, 18—25 × 18—20 μ, producing zoospores on germination; oospore globose, wall brown or yellowish-brown, densely covered with minute warts, which sometimes become spinulose, 50—65 μ diam.

Parasitic on *Spergularia rubra, Arenaria media,* and other caryophyllaceous plants.

Cystopus bliti, De Bary. Sori variable in size, gregarious, swollen, yellowish white; conidiophores somewhat club-shaped; conidia of two shapes, the terminal one globose, with a thick wall, the remainder obovate, apex broadly rounded, base truncate, the wall with a thickened ring at the central part, 15—20 × 14—18 μ; oospore globose, wall netted, the ridges forming pentagons or hexagons, 55—65 μ diam.

Syn. *Cystopus amaranthi,* Schwein.
Cystopus amaranthacearum, Zal.

Parasitic on stems and leaves of various species of *Amaranthus, Cyatula* and *Achnida.*

Cystopus tragopogonis, Schroet. Sori variable in size, irregularly globose or oblong, compressed, white, or sometimes with a tinge of yellow, becoming powdery; conidia of two different shapes, the terminal one much larger than the rest, depressed globose and usually indented or umbilicate at the base, wall thick, colourless or tinged yellow,

sterile ; the remainder shortly cylindrical, or cuboid, wall colourless, thin, with a thickened central, or equatorial zone, producing zoospores on germination, 18—23 μ diam. ; oospore globose, yellowish-brown, markings somewhat variable, and not strongly pronounced, with a raised network having spines springing from the ridges, and minutely warted on the areas included by the network, or with rather large, hollow warts, which in turn are minutely warted, 45—65 μ diam.

Syn. *Cystopus cubicus*, Lév.
Cystopus spinulosus, De Bary.

On both surfaces of living leaves of Goats'-beard (*Tragopogon pratensis*), and many other plants belonging to the order Compositae.

PHYTOPHTHORA, De Bary

Mycelium branched, running between the cells of the host-plant, and giving off slender haustoria which enter the cells ; conidiophores solitary or in clusters, emerging through the stomata, or bursting through the epidermis, simple below, becoming variously branched above, sometimes forking ; conidia elliptical, tip papillate ; producing zoospores on germination, the conidia are produced at the tips of the conidiophores, but after the formation of a conidium, the conidiophore increases in length, and again bears a conidium at its tip ; the conidiophores becoming swollen or knotted at the point of origin of each conidium ; oospores globose, smooth, coloured.

Recognised by the knotted appearance of the upper portion of the conidiophores in *P. infestans*, the knots or swellings corresponding to the point of origin of conidia. In some instances a conidium persists after the conidiophore has grown out above it, and consequently appears as if it had originated laterally on the conidiophore.

KEY TO THE SPECIES

infestans. Conidiophores knotted towards the tip. Parasitic on plants belonging to Solanaceae.

omnivora. Conidiophores not knotted towards the tip. Parasitic on plants belonging to various orders, Crassulaceae, Cactaceae, Cupuliferae, etc.

[*phaseoli*, Thaxt. Conidiophores knotted towards the tip ; conidia on germination sometimes producing zoospores, at others a promycelium. Parasitic on plants belonging to Leguminosae (*Phaseolus*).]

[*nicotianae*, Breda de Hann. Conidia pear-shaped, 36 × 25 μ. Parasitic on plants belonging to Solanaceae (*Nicotiana*).]

Phytophthora omnivora, De Bary. Spots on the leaves often somewhat vague and indistinct; conidiophores either solitary or in tufts, emerging through the stomata, or bursting through the epidermis, simple, small, often bearing only one or two conidia, not swollen at the point of origin of the conidia, which are lemon-shaped, colourless, 50—70 × 35—38 μ; oospores globose, smooth, brown, 25—30 μ diam.

Syn. *Peronospora cactorum,* Cohn and Lebert.
Peronospora sempervivi, Schenk.
Peronospora fagi, Hartig.

Many different kinds of plants are attacked by this parasite, more especially in the seedling condition. In this country it is perhaps most abundant on the cotyledons of the beech (*Fagus sylvatica*), but also occurs on cultivated plants. It has been recorded as attacking plants belonging to the following genera: *Fagus, Melocactus, Cereus, Sempervivium, Cleome, Clarkia, Schizanthus, Cactus, Acer, Fraxinus, Robinia, Lepidium, Fagopyrum, Oenothera, Epilobium* and *Salpiglossis.*

Hartig; *Unters. aus dem Forstbot. Institut,* 1880, p. 33.
De Bary; *Beitr. zur Morphol. und Phys. der Pilze,* 1881, p. 22.

Phytophthora infestans, De Bary. Spots formed on the leaves are at first pale yellowish-green, then brown, becoming blackish when old, the edge of the spot often fringed with the white conidiophores, which emerge through the stomata either singly or in small tufts, or in some instances they burst directly through the epidermis; conidiophores variable in length, somewhat slender and sparingly branched, swollen at intervals upwards, at points corresponding to the origin of the conidia; conidia elliptical or lemon-shaped, with a very short stem at the base, wall thin, colourless, 20—32 × 15—24 μ, producing zoospores on germination. Oospores unknown.

Syn. *Botrytis infestans,* Mont.

This fungus is the cause of the terrible scourge known as "Potato disease," which was first observed in 1840, and by 1845 had become general throughout Europe. Notwithstanding the absence of oospores, the fungus is able to reproduce itself by two methods, and to perpetuate its

continuance from year to year. The zoospores, liberated from the conidia, are dispersed by rain, birds, animals, insects, etc., and infect neighbouring plants, thus promoting the rapid spread of the disease. The zoospores, however, are short-lived, and only facilitate the spread of the disease during the period that the host-plant is actively growing. The continuance of the parasite from year to year depends on the presence of mycelium in the tubers. When a tuber containing mycelium is planted, the mycelium grows in the tissues of the sprouts, and passes upwards through the stem into the leaves, where in course of time it produces the conidial form of reproduction on the under surface of the leaves. By means of hibernating mycelium in the tubers, the disease has been carried from place to place, and is now unfortunately present in every quarter of the world where the potato is cultivated.

Abundant on the potato plant (*Solanum tuberosum*), also on the foliage of many other species of *Solanum*, both wild and cultivated, also on the tomato (*Lycopersicum esculentum*).

De Bary, *Journ. Roy. Agric. Soc. Engl.*, p. 12 (1876).
Jensen, *Mem. Soc. Agric.*, p. 131 (1877).
Massee, *Dis. Cult. Pl.*, p. 123
Ward, *Diseases of Plants*, p. 59.

BASIDIOPHORA, Roze and Cornu

Mycelium branched, running between the cells of the host-plant, and sending vesicular haustoria into the cells; conidiophores stout, simple, tip swollen and bearing several broadly elliptical conidia, which produce zoospores on germination; oosphere furnished with a very thick, hard wall; oospore globose, coloured.

Readily distinguished by the simple, or unbranched conidiophores each bearing a cluster of large, almost sessile conidia at the swollen tip.

Only one species known.

Basidiophora entospora, Roze and Cornu. Forming ochraceous then brownish patches on the upper surface of the leaf, the corresponding areas whitish on the under surface; conidiophores solitary or several, emerging through the stomata, stout, simple, tips swollen, 150—300 × 12—15 μ; conidia broadly elliptical, tip papillate, springing in clusters from the swollen tips of the conidiophores, supported on very short, cylindrical stalks, colourless,

30—40 × 10—18 μ; oospores globose, yellowish, more or less veined, 40—50 μ diam.

Syn. *Plasmopara entospora*, Schroet.

On living leaves, more especially the radical ones, of species of *Aster* and *Erigeron*.

SCLEROSPORA, Schroet.

Mycelium furnished with vesicular haustoria; sporophores sparingly branched; conidia broadly elliptical, tip with a minute wart or papilla, producing zoospores on germination; oospores globose, wall very thick, multistratose, coloured.

Remarkable for the very thick wall of the oosphere, and in this respect approaching the genus *Plasmopara*, differing however, in the structure of the conidiophores.

KEY TO THE SPECIES

graminis. Conidia subglobose. Parasitic on various grasses.

[*kriegeriana*, Magnus. Conidia unknown. Oogonia subglobose, with a very thick wall, produced in series in the tissue of the host, 60—65 μ diam. Parasitic on grasses (*Phalaris*)].

[*magnusiana*, Sorok. Conidia unknown. Oospore subglobose, wall somewhat wrinkled, thick, brown, 35—50 μ diam. Parasitic on a species of *Equisetum*.]

Sclerospora graminis, Schroet. Spots formed on the leaves, effused; conidiophores erect, springing singly or in small tufts, easily overlooked, about 100 μ high by 10—12 μ thick, branched above, branches rather stout, compact, usually terminating in 2—3 short branchlets, which bear the broadly elliptical, smooth, colourless conidia, 20 × 15—18 μ; oosphere subglobose, with a reddish-yellow wall up to 12 μ in thickness, 50—60 × 40—45 μ; oospore globose, smooth, yellowish.

Syn. *Sclerospora macrospora*, Sacc.

The conidiophores are stouter than in other species, the branches being variable in number, short, thick, not spreading, and terminating in 2—3 short branchlets. The whole structure soon collapses.

So far as at present known this parasite is confined to grasses, and has been recorded on leaves of species of *Phalaris*, *Alopecurus*, *Setaria* and Indian corn (*Zea mays*).

Peglioni, an Italian botanist, states that the dissemination of *Sclerospora* in cereals is effected by the presence of

mycelium under the outer coating of the seed. Grain from a diseased head were sown without any treatment; some did not germinate, and those that grew presented abnormal characters, and microscopic examination showed the presence of mycelium in the younger parts of the plants.

The following appears to support this statement. Seed of *Saccharum officinale*, obtained from France, was sown in a plot adjoining the Jodrell Laboratory, Kew Gardens. Two of the resulting plants were infested with *Sclerospora graminis*, and two other plants were badly "smutted" with *Ustilago sacchari*. Neither of these fungi had previously been recorded as occurring in Britain, so that direct infection from spores was out of the question, and it is practically certain that in both cases, the source of infection was imported along with the seed. By such means diseases are conveyed, unconsciously, from one part of the world to another.

Cugini, *Lc. Statione sper. Agrar. Ital.*, 35, p. 46.
Peglioni, *Atti. Reale Acad. Lincei*, 305, p. 509.

PLASMOPARA, Schroet.

Mycelium stout, irregular, furnished with globose or elliptical haustoria; conidiophores erect, solitary or in tufts, emerging through the stomata, sparingly branched, branches usually monopodially arranged, not truly forked, spreading; conidia elliptical, generally with a papilla or wart at the tip, colourless, producing zoospores on germination; oospores globose, coloured, wall thick.

Forming delicate white films on living leaves, and along with other genera, are popularly known as moulds.

KEY TO THE SPECIES

pygmaea. Parasitic on members of the order Ranunculaceae.
pusilla. On plants belonging to the order Geraniaceae.
densa. On plants belonging to Scrophulariaceae.
viticola. Growing on plants belonging to the Vine family.
nivea. Growing on plants belonging to the order Umbelliferae.
[*geranii*, Berl. and De Toni. Conidia obovate, 24—28 × 12—15 μ; oospore globose, 25—35 μ diam. On plants belonging to Geraniaceae. *Geranium robertia num*, etc.]
[*impatientis*, Berl. Ellis and Everh. Conidia globose, 12—14 μ diam. On *Impatiens fulva.*]

[*epilobii*, Schroet. Conidia shortly elliptical, 15—21 × 14—18 μ; oospore, 25—35 μ diam. On *Epilobium palustris* and *E. parviflora*.]

[*heliocarpi*, Lagerh. Conidia elliptical, warted at the tip, 30—40 × 24—30 μ. On *Heliocarpus americanus*].

[*obducens*, Schroet. Conidia broadly elliptical, with a wart at the tip, 16—21 × 12—15 μ; oospore globose, 25—30 μ diam. On *Impatiens fulva*, covering the under surface of the cotyledons.]

[*celtidis*, Berl. Conidia elliptical, 26—30 × 14—20 μ; oospore, 28—36 × 30—44 μ. On *Celtis occidentalis*.]

[*australis*, Swingle. Conidia broadly elliptical, 14—17 × 10—13 μ. On leaves of *Cyclanthera hystrix*.]

[*ribicola*, Schroet. Conidia elliptical, 15—20 × 11—13 μ. On leaves of *Ribes rubrum*.]

[*halstedii*, Berl. and De Toni. Conidia broadly elliptical, 25—30 × 15—20 μ. On leaves of various plants belonging to the Compositae. *Ambrosia*, *Bidens*, *Rudbeckia*, *Silphium*, *Helianthus*, *Solidago*, etc.]

Plasmopara pygmaea, Schroet. Forming pale spots on the leaf, the tufts of conidiophores effused, whitish, mycelium thick, irregularly constricted here and there, haustoria minute, mostly pear-shaped; conidiophores tufted, emerging through the stomata, somewhat spreading from the base, 100—170 × 8—15 μ, often slightly thickest upwards, with a few short, rather stout conidia-bearing branches near the tip, the branches sometimes bearing 2—3 short branchlets, which are abrupt or truncate at the tip, after the conidia have fallen away; conidia broadly elliptical, with a papilla at the tip, size variable, 18—28 × 15—22 μ, colourless; oospore globose, smooth or minutely rugulose, wall thin, wall of oosphere thick, yellowish, 45—55 μ thick, producing zoospores on germination.

Syn. *Peronospora pygmaea*, Unger.

On leaves of various ranunculaceous plants, as Wood anemone (*Anemone nemorosa*), and other species of *Anemone*, *Aconitum*, *Hepatica*, *Isopyrum*, *Thalictrum*, etc.

Forming minute whitish tufts that in course of time become greyish brown. The conidiophores are often unbranched and furnished near the tip with 2—5 short spine-like outgrowths bearing the conidia.

Plasmopara pusilla, Schroet. Forming effused whitish patches, conidiophores in tufts up to 20, emerging through

the stomata, 70—130 × 8—10 μ, with a few quite short branches near the tip, some of the branches remain simple, others bear 2–3 short branchlets, the tips of which are truncate after the oospores have fallen away; conidia broadly elliptical, or broadly pear-shaped, with an apiculus or wart at the base, colourless, size variable, 25—40 × 18—25 μ; oospore unknown.

Syn. *Peronospora pusilla*, De Bary.

Parasitic on living leaves of *Geranium pratense*, *G. phaeum*, *G. silvaticum* and other species.

Plasmopara densa, Schroet. Tufts usually small, dense, scattered or confluent, white, becoming tinged yellow with age; mycelium with vesicular haustoria; conidiophores emerging in tufts through the stomata, 150—180 × 8—10 μ, dividing upwards into two or three main branches, each of which bears 1—3 branchlets; conidia broadly elliptical, or sometimes almost globose, in other examples broadly lemon-shaped, minutely and bluntly warted at the tip as a rule, 17—23 × 12—17 μ, colourless; oospore yellowish, 25—35 μ diam.

Syn. *Peronospora densa*, Rabenh.
Peronospora nivea, Unger.

Parasitic on plants belonging to the order Scrophulariaceae, *Bartsia*, *Euphrasia*, *Pedicularis*, *Alectorolophis*, etc.

Plasmopara viticola, Berl. and De Toni. Spots on the upper surface of the leaf at first yellowish-green, then brownish and becoming dry; on the under surface, on areas corresponding to these spots, a delicate white mould is present, more especially towards the circumference; conidiophores emerging in tufts from the stomata, soon spreading, base thickened, 250—500 × 9—12 μ, simple for some distance, then with 4—5 main branches spreading almost at right-angles, these each bear 3—4 opposite pairs of shorter branches, each of which in turn, bears 2—4 short branchlets at the tip, on which the conidia are borne; conidia broadly elliptical or sometimes almost globose, colourless, size variable, 18—30 × 12—17 μ, producing zoospores on germination; oospores globose, smooth or more or less marked with slightly-raised veins, 30—35 μ diam.

Syn. *Botrytis viticola*, Berk.
Peronospora viticola, Casp.

Parasitic on plants belonging to the order Vitaceae,

more especially the grape vine (*Vitis vinifera*), many other species of *Vitis* and *Ampelopsis* are also attacked.

This destructive parasite, which has been the ruin of numerous vineyards in Europe, is a native of the United States. It was introduced into France about the year 1878, along with American vines that were imported to replace those destroyed by the *Phylloxera*, also a pest of American origin. The mildew attacks the foliage, young shoots, tendrils, flowers and young fruit of the Vine, but usually appears first, and is most abundant on the leaves, which are often killed within a fortnight of the appearance of the disease. During the autumn the winter form of fruit, or resting-spores, are produced in great numbers in the tissues of diseased leaves. When the leaves decay, the resting-spores are not injured, but remain in the soil until the following spring, when they germinate, producing two or three conidiophores, similar to those present on the leaves during the summer. The conidia present on these conidiophores infect the vines early in the season, being carried by wind, etc.

Plasmopara nivea, Schroet. Spots on the upper surface of the leaf, yellowish-green, then brownish and becoming dry, the conidiophores form rather dense, white patches on corresponding areas on the under surface of the leaf; mycelium stout, often contorted, haustoria numerous, pear-shaped; conidiophores tufted, emerging through the stomata, 150—300 × 8—10 μ, tapering upwards, simple or with 3—5 alternate, primary branches near the tip, these branches bear 3—5 tapering branchlets at the tip, or bear 1—3 short lateral branches, which are divided into 2—3 short, stout, tapering branchlets at the tip, colourless; conidia broadly elliptical, with a vague apical papilla, colourless, 21—32 × 12—22 μ, producing zoospores on germination; oospore globose, yellowish-brown, smooth or slightly wrinkled, 28—40 μ diam.

Syn. *Botrytis nivea*, Unger.
Peronospora nivea, Unger.
Peronospora umbelliferarum, Casp.

Parasitic on living leaves of various umbelliferous plants, Goutweed (*Aegopodium podagraria*), *Anthriscus sylvestris*, *Angelica sylvestris*, *Pimpinella magna*, *P. saxifraga*, *Sium latifolium*, *Pastinaca sativa*, *Petroselinum sativum*, *Peucedanum palustre*, *Daucus carota*, *Conium maculatum*,

Meum at amanticum, also on plants belonging to the following genera.

In many plants the mycelium of the fungus is perennial in the root, and grows up with the above-ground parts year by year.

BREMIA, Regel

Mycelium branched, swollen here and there, running between the cells of the host-plant, and sending small, vesicular haustoria into the cells; conidiophores generally tufted, erect, repeatedly forking upwards, the terminal branchlets ending in a more or less circular, concave disc, from the margin of which spring short processes bearing the broadly elliptical, colourless conidia; oospheres subglobose, with a thick wall; oospores pale yellow, globose.

Readily distinguished from all other genera by the peculiar flattened disc at the tips of the branchlets, from which the conidia spring.

Only one species known.

Bremia lactucae, Regel. Forming yellowish-green expansions on the upper surface of the leaf, the corresponding parts of the under surface, more or less, covered with a very delicate, white mildew; conidiophores originating either singly or in tufts, erect, rather rigid, 300—600 × 10—12 μ, repeatedly forking above, or the branches rarely in threes, the ultimate branchlets bearing a more or less circular, saucer-shaped body, from the edge of which spring several short projections, each bearing a conidium; conidia broadly elliptical, or almost globose, with a large flattened wart at the tip, colourless, 15—24 × 15—24 μ; oosphere globose, wall thick, yellowish; oospore globose, pale yellow or brownish, often wrinkled, 25—35 μ.

Syn. *Botrytis lactucae*, Unger.
Botrytis ganglioniformis, Berk.
Peronospora ganglioniformis, De Bary.

Parasitic on the leaves of plants belonging to the order Compositae, as species of *Lactuca, Senecio, Helichrysum, Cirsium, Centaurea, Lapsana, Leontodon, Tragopogon, Hypochaeris, Mulgedium, Sonchus, Crepis, Hieracium*, etc.

It is very destructive to cultivated lettuce (*Lactuca scariola*, var. *sativa*), more especially when grown under glass, and in a damp atmosphere.

PERONOSPORA, Corda

Mycelium branched, swollen here and there, haustoria generally slender and branched, rarely vesicular or pear-

shaped; tufts of mildew formed by the conidiophores more or less effused, rather dense, usually more or less grey in colour; conidiophores either solitary or tufted, usually emerging through the stomata, cylindrical, generally repeatedly forked above, the ultimate branchlets either straight or curved, pointed; conidia elliptical, without a papilla or wart at the tip (except in one species), colourless or tinged dingy violet, germinating by the protrusion of a branch of mycelium, or germ-tube; oosphere subglobose, with a thin, almost or quite colourless wall; oospore with a somewhat thick wall, which is often ornamented with raised lines, etc., coloured.

The species included in this genus form a thin, whitish or greyish mildew on the leaves and other parts of living plants. Known amongst allies by the elongated, slender, often branched haustoria, and by the absence of a papilla or wart at the tip of the conidium.

All the species are true parasites, and many prove very destructive to cultivated plants.

KEY TO THE SPECIES

A. *Divaricatae*

Branches of the conidiophores all straight, or scarcely curved.

Parasitic on petals of plants belonging to the order Dipsaceae . . . . . *violacea.*

Parasitic on plants belonging to the order Valerianaceae. *valerianae.*

Parasitic on plants belonging to the order Liliaceae. *schleideni.*

Parasitic on plants belonging to the order Chenopodiaceae *schactii.*

Parasitic on plants belonging to the order Polygonaceae, *Rumex* . . . . . *rumicis.*

Parasitic on plants belonging to the order Caryophyllaceae, *Silene* and *Dianthus* . . . . . *dianthi.*

Parasitic on plants belonging to the order Caryophyllaceae, *Arenaria* . . . . . *arenariae.*

Parasitic on plants belonging to the order Polygonaceae, *Polygonum* . . . . . *polygoni.*

Parasitic on plants belonging to the order Galiaceae. *calotheca.*

Parasitic on plants belonging to the order Caryophyllaceae, *Cerastium, Stellaria* . . . . . *alsinearum.*

Parasitic on plants belonging to the order Leguminosae, *Trifolium*, *Medicago*, *Ononis*, etc. . . *trifoliorum*.

Parasitic on plants belonging to the order Scrophulariaceae. *grisea*.

Parasitic on plants belonging to the order Violaceae. *violae*.

Parasitic on plants belonging to the order Papaveraceae. *arborescens*.

[Parasitic on plants belonging to the order Violaceae, *Viola tricolor*, var. *arvensis*. Forming whitish patches on the leaves. Conidia broadly pear-shaped, with a broad wart at the tip, 80—95 × 40—45 μ, colourless; oospore pale yellowish, globose, 36—40 μ diam. *megasperma*, Berl.]

[Parasitic on plants belonging to the order Linaceae. Tufts minute, white; conidia elliptical, becoming tinged brown, 18—20 × 13 μ; oospores 22—26 μ diam. . . . . *lini*, Schr.]

[Parasitic on plants belonging to the order Compositae. Tufts effused, dense, white. Conidia broadly cylindrical, colourless, 32—42 × 18—25 μ, oospores with a brown wall having a network, 30 μ diam. *leptosperma*, De Bary.]

[Parasitic on plants belonging to the order Compositae. Patches small, dingy violet. Conidia elliptical, dingy lilac, 28—39 × 17—21 μ; oospores brown. *radii*, De Bary].

[Parasitic on the corollas of plants belonging to the order Campanulaceae. Patches grey. Conidia elongated elliptical, dingy lilac, 35—40 × 17—20 μ; oospores with a thick, brown wall, 32—36 μ diam. *corollae*, Tranzsch.]

[Parasitic on plants belonging to the order Solanaceae. Patches greyish. Conidia broadly pear-shaped, 22—27 × 16—20 μ, pale grey . . . . . *dubia*, Berl.]

[Parasitic on plants belonging to the genus Gonolobia. Conidia broadly elliptical, pale greyish, 18—20 × 16—21 μ . . . . . *gonolobi*, Lagerh.]

[Parasitic on plants belonging to the genus Borreria. Tufts effused, dense, dingy white. Conidia elliptical, 15—18 × 12—14 μ, colourless. *borreriae*, Lagerh.]

[Parasitic on leaves of plants belonging to the order Euphorbiaceae. Patches dingy greyish-violet. Conidia broadly elliptical, dingy lilac, 22—26 × 16—20 μ. *whippleae*, Ell. and Ev.]

[Parasitic on plants belonging to the order Euphorbiaceae, Euphorbia cyparissia. Conidia broadly elliptical, dingy lilac, 22—26 × 16—20 μ. *cyparissiae*, De Bary]

[Parasitic on plants belonging to the order Portulaceae. Tufts effused, greyish; conidia elliptical, lilac, 25—30 × 11—12 μ; oospores angularly globose, ochraceous, 36—42 μ diam . . . . . *claytoniae*, Farlow.]

[Parasitic on plants belonging to the order Euphorbiaceae, species of *Euphorbia*. Patches whitish; conidia subglobose, colourless, 18—22 × 16—20 μ; oospore globose, 30—35 μ diam., yellowish. . *euphorbiae*, Fuckel.]

[Parasitic on plants belonging to the order Dipsaceae. Patches dense, greyish; conidia elliptical, 25—30 × 16—20 μ . . . . . *dipsaci*, Tub.]

[Parasitic on plants belonging to the order Campanulaceae. Tufts greyish-violet; conidia elliptical, 20—26 × 14—17 μ; oospores yellowish, 30—35 μ diam. *phyteumatis*, Fuckel.]

[Parasitic on plants belonging to the order Leguminosae, Patches dingy white with corresponding brown spots on upper surface of leaf; conidia elliptical, 23—24 × 17—18 μ, colourless; oospores globose, wall thick, with a large, loose network. On Laburnum. *cytisi*, Magn.]

[Parasitic on plants belonging to the order Valerianaceae. Patches dense, dingy lilac; conidia broadly elliptical, 23—28 × 16—20 μ; oospores smooth, 36—42 μ diam. . . . . *valerianellae*, Fuckel]

[Parasitic on plants belonging to the order Apocynaceae. Patches white, effused. Conidia elliptical, colourless or tinged brown, 24—28 × 16—18 μ; oospores subglobose, brown, 24—28 μ diam. . . *vincae*, Schr.]

[Parasitic on plants belonging to the order Labiatae. Patches greyish-violet; conidia subglobose, dingy lilac, 22—27 × 18—20 μ; oospores subglobose, 30—34 μ diam. . . . . *lophanthi*, Farl.]

B. *Intermediae*

Branches of the conidiophores more or less curved, ultimate branchlets spreading and recurved, or sometimes curved inwards, or towards each other.

Parasitic on plants belonging to the order Chenopodiaceae. *effusa*.

Parasitic on plants belonging to the order Boraginaceae. *myosotidis*.

Parasitic on plants belonging to the order Leguminosae. *viciae.*

Parasitic on plants belonging to the order Fumariaceae. *affinis.*

Parasitic on plants belonging to the order Labiatae. *lamii.*

Parasitic on plants belonging to the order Scrophulariaceae. *sordida.*

Parasitic on plants belonging to the order Rosaceae. *sparsa.*

[Parasitic on plants belonging to the order Onagraceae. Patches greyish-white; conidia elliptical, greyish-lilac, 20—28 × 16—18 μ; oospores globose, 40—50 μ diam. . . . . *arthuri*, Farl.]

[Parasitic on plants belonging to the order Hydrophyllaceae. Tufts effused, yellowish, then brown; conidia elliptical, 28—35 × 19—25 μ; oospores subglobose, brown, 39—45 μ diam. . . *hydrophylli*, Waite.]

[Parasitic on plants belonging to the order Rosaceae. Conidia elliptical, 20—25 × 15—18 μ, tinged lilac; oospore yellowish, wall smooth. *potentillae*, De Bary.]

[Parasitic on plants belonging to the order Aroideae. Conidia broadly pear-shaped, 12 × 10 μ; oospores brown, wall with a network. . *trichotoma*, Mass.]

[Parasitic on plants belonging to the order Saxifragaceae. Tufts greyish white; conidia elliptical, 20—25 × 16—19 μ; oospores globose, 36—40 μ diam. *chrysosplenii*, Fckl.]

[Parasitic on plants belonging to the order Ranunculaceae. Patches dense, greyish; conidia elliptical, 25—30 × 18—22 μ, dingy lilac . . . *pulveracea*, Fckl.]

[Parasitic on plants belonging to the order Caryophyllaceae, *Holostea*. Patches dense, whitish or greyish-lilac; conidia broadly elliptical, 25—30 × 16—22 μ tinged lilac; oospores with the wall minutely but densely warted. *holostei*, Casp.]

[Parasitic on plants belonging to the order Labiatae. Patches obsolete; conidia globose and colourless or brownish, 24—30 × 14—17 μ; oospores with a smooth wall, subovate, 35—50 × 27—36 μ diam. *hedeomatis*, Kell.]

[Parasitic on plants belonging to the order Nyctaginaceae. Patches dense, greyish. Conidia elliptical, 20—27 × 17—18 μ, tinged lilac; oospores subglobose, wall rough, 35—40 μ diam. *oxybaphi*, Kell. and Swing.]

[Parasitic on plants belonging to the order Primulaceae. Patches dense, whitish or tinged lilac ; conidia broadly elliptical, 20—26 × 16—20 μ ; oospores smooth or wrinkled, 30—33 μ diam. . . . *candida*, Fuckel.]

[Parasitic on plants belonging to the order Scrophulariaceae, *Euphrasia*. Conidia lemon-shaped, tinged violet, 30—36 × 19—24 μ ; oospore globose, brown, 27 μ diam. . . . . *lapponica*, Lagerh.]

[Parasitic on plants belonging to the order Scrophulariaceae, *Antirrhinum*. Patches dense, greyish-lilac ; Conidia elliptical, tinged violet, 25—27 × 15—17 μ . oospores 30—36 μ diam. . . *antirrhini*, Schroet.]

C. *Undulatae*

All the branches of the conidiophore more or less curved or wavy, the ultimate branchlets spreading and curved, sometimes inwards, or towards each other, sometimes recurved, or away from each other.

Parasitic on plants belonging to the order Ranunculaceae. *ficariae*.

Parasitic on plants belonging to the order Urticaceae. *urticae*.

Parasitic on plants belonging to the order Plantaginaceae. *alta*.

Parasitic on plants belonging to the order Cruciferae. *parasitica*.

[Parasitic on plants belonging to the order Scrophulariaceae. Patches white then lilac, sometimes with a tinge of yellow ; conidia elliptical, 24—28 × 18—22 μ, faintly tinged lilac ; oospores 30—34 μ diam. *linariae*, Fuckel.]

[Parasitic on plants belonging to the order Palmaceae. Patches whitish ; conidia elliptical, 26—29 × 16—20 μ, almost colourless ; oospores globose, coarsely warted, yellowish brown, 32—48 μ diam. *phlogina*, Deit.]

[Parasitic on plants belonging to the order Ranunculaceae. Patches dense, dingy white ; conidia elongated elliptic, tinged yellow ; oospores angularly globose, dusky yellow or brown . . . . . *eranthidis*, Fisch.]

[Parasitic on plants belonging to the order Geraniaceae. Patches dense, effused, whitish, becoming dingy lilac ; conidia elliptical, tinged greyish-lilac, 23—27 × 16—20 μ ; oospores globose, 32—36 μ diam., smooth. *conglomerata*, Fuckel.]

[Parasitic on plants belonging to the order Santalaceae *Thesium*. Patches small, whitish; conidia almost globose, 15—20 × 14—17 μ, colourless.
thesii, Lagerh.]

[Parasitic on plants belonging to the order Fumariaceae, *Corydalis*. Patches dingy white, or tinged lilac; conidia elliptical, tinged lilac, 24—30 × 16—20 μ; oospores globose, 32—37 μ diam. *corydalis*, De Bary.]

[Parasitic on plants belonging to the order Campanulaceae. Patches small, greyish-white; conidia pear-shaped, almost colourless, 20—27 × 13—17 μ.
niessleana, Berl.]

[Parasitic on plants belonging to the order Zygophyllaceae. Tufts dense, white or greyish; conidia broadly pear-shaped, 21—30 × 20—24 μ, colourless.
tribulina, Pass.]

A. *Divaricatae*

Peronospora violacea, Berk. Forming minute, scattered, soft, pale dingy lilac patches; mycelium with vesiculate haustoria; conidiophores short, erect, 150—300 × 25—35 μ, base somewhat thickened, 5—7 times forked upwards, primary branches few in number, erect, ultimate branchlets short, erect, all the branches fairly straight, angles formed by the branching, sharp; conidia elliptical or slightly narrower towards the base, pale dingy lilac, 30—50 × 16—25 μ; oosphere with a fairly thick wall; oospore subglobose, wall 5—8 μ thick, becoming brown, more or less wrinkled, 30—40 μ diam.

This may possibly prove to be identical with a fungus named *Botrytis violacea*, by Leveille (*Ann. Sci. Nat.*, 1846, p. 298), said to have erect hyphae, continuously forked, and bearing smooth, violet conidia. It occurred on flowers of *Pyrethrum arvense*, and on leaves of *Lathyrus palustris*, in France.

Peronospora violacea is parasitic on the petals of various plants belonging to the order Dipsaceae, more especially on those of *Scabiosa arvensis*. Petals that are infected soon become flaccid and assume a brownish tinge.

The vesicular or small, pear-shaped haustoria, possessed by this species, are very unusual in the genus.

Peronospora valerianae, Trail. Patches of mildew not well defined, greyish-violet; conidiophores 5—6 times forked, ultimate branchlets 7 μ long, spreading, slightly curved, scarcely tapering; conidia obovate, or obovate-

elliptical, 27—30 × 22—24 μ, dingy brownish-violet; oospore unknown.

On leaves of *Valeriana officinalis*.

Peronospora schleideni, Unger. Patches of mildew effused, rather dense, dingy greyish-lilac; conidiophores large and stout, 250—600 × 12—16 μ, emerging from the stomata singly or in tufts, branching alternately in a forked manner, ultimate and penultimate branches more or less curved; conidia large, broadly pear-shaped, tip blunt or somewhat pointed, pale dingy violet, 40—55 × 20—27 μ; oospores broadly elliptical or subglobose, wall thin, smooth.

Syn. *Botrytis destructor*, Berk.
Peronospora destructor, Casp.
Botrytis parasitica, Schleiden.

Parasitic on various species of *Allium*. Often very destructive to the cultivated onion (*Allium cepa*).

Peronospora schactii, Fuckel. Forming very dense patches, at first white, then gradually changing to dingy greyish-violet; conidiophores emerging from the stomata singly or in tufts, 250—350 × 7—8 μ, repeatedly forked above, ultimate and penultimate branches often curved; conidia broadly elliptical, tinged brown, 22—27 × 17—20 μ; oospores globose, with a thick, smooth, brown wall.

Syn. *Peronospora betae*, Kuhn.

Parasitic on plants belonging to the order Chenopodiaceae.

This parasite is responsible for much injury to Beet (*Beta vulgaris*), also to sugar beet and mangolds. The younger central leaves are most frequently attacked, and in the case of seedlings growth is materially checked, or in many instances killed outright.

Peronospora rumicis, Corda. Patches of mildew dense, broadly effused, dingy greyish-violet; conidiophores emerging from the stomata in small tufts, or singly, 450—650 × 9—11 μ, repeatedly forked upwards, the ultimate branchlets spreading; conidia broadly elliptical, tip very blunt and rounded, dingy violet, 26—33 × 16—22 μ; oospores unknown.

Syn. *Peronospora effusa*, var. *rumicis*, Fuckel.

Parasitic on leaves, stem and inflorescence of Sorrel (*Rumex acetosa*), also on *Rumex acetosella*, *R. crispa*, etc.

Peronospora dianthi, De Bary. Patches of mould dense, broadly effused, dingy greyish-violet; conidiophores

erect, 300—500 × 8—10 μ, repeatedly forked upwards, ultimate branchlets spreading, straight as a rule; conidia broadly elliptical or broadly pear-shaped, tip rounded, dingy greyish-violet, 18—28 × 15—18 μ; oospore globose, yellowish brown, warted, or with irregular raised ridges, which sometimes show a tendency to form an irregular network here and there, 35—40 μ diam.

Syn. *Peronospora conferta*, form *agrostemmatis*, Fuckel.

Parasitic on caryophyllaceous plants, as *Silene*, *Dianthus*, *Agrostemma*, etc.

Peronospora arenariae, De Bary. Forming dense tufts of mould of a greyish-white colour; conidiophores emerging singly or in small tufts, through the stomata, slender, 250—450 × 8—10 μ, repeatedly forked above, ultimate branchlets spreading, straight or slightly curved; conidia elliptical, colourless, 14—17 × 9—13 μ; oospore globose, wall chestnut brown, covered with stout hemispherical warts, sometimes mixed with others more cylindrical in form, 30—35 μ diam.

Syn. *Botrytis arenariae*, Berk.
Peronospora conferta, Unger.

Parasitic on plants belonging to the order Caryophyllaceae, as *Stellaria media*, *Arenaria serpyllifolia*, *A. trinervis*, etc.

This species is closely allied to *Peronospora dianthi*, and by some authors is considered as only a form of that species. It differs in the whitish colour of the patches of mould, and the colourless conidia.

Peronospora polygoni, Thuemen. Patches of mildew dense, effused, dingy violet; conidiophores emerging through the stomata, usually in considerable numbers, 320—420 × 9—11 μ, repeatedly forked above, branches of the second and third orders usually spreading and curved; conidia of an elongated elliptical shape, or slightly narrowed below and with a tendency to become pear-shaped, 30—40 × 15—20 μ, tinged greyish. Oospores unknown.

Parasitic on leaves of plants belonging to the order Polygonaceae, as *Polygonum convolvulus*, *P. aviculare*, etc.

Differs from *Peronospora rumicis*, which grows on plants belonging to the same order, in having larger, and paler coloured conidia.

Peronospora calotheca, De Bary. Tufts of mildew soft and greyish; conidiophores rather slender, generally

emerging singly through the stomata, 500—700 × 10—12 μ, 7—9 times forked above, primary branches suberect, the remainder spreading, often slightly curved; conidia elliptical, tip rounded, faintly tinged lilac, 20—30 × 14—17 μ; oosphere globose, with a thin, colourless wall; oospore globose, with a thickish bay-coloured wall, having thin ridges anastomosing to form a very small-meshed network, 36—44 μ diam.

Syn. *Peronospora galii*, Fuckel.
Peronospora sherardiae, Fuckel.

Parasitic on plants belonging to the order Galiaceae, as *Galium verum*, *G. aparine*, *G. palustris*, *Asperula odorata*, *Sherardia arvensis*, etc.

Peronospora alsinearum, Casp. Tufts of mildew dense, broadly effused, greyish-white; conidiophores 250—350 × 8—9 μ, repeatedly forked above, primary branches straight, the remainder more or less curved and spreading; conidia elliptical, proportional length to breadth variable, tip blunt, 22—30 × 15—19 μ, tinged lilac; oosphere with a thin, colourless wall; oospore globose, with a thick yellowish-brown wall covered with a network of raised lines, 40—45 μ diam.

Syn *Peronospora conferta*, Unger.
Peronospora lepigoni, Fuckel.
Peronospora tomentosa, Fuckel.
Peronospora scleranthi, Rabenh.
Peronospora obovata, Bon.

Parasitic on plants belonging to the order Caryophyllaceae, as *Cerastium arvense*, *C. glomeratum*, *C. semidecandrum*, *C. triviale*, *Stellaria media*, *Scleranthus annuus*, *Spergula arvensis*, *S. rubra*, etc.

Differs from *Peronospora arenariae* and *P. dianthi* in the larger conidia, and in the very small network on the wall of the oospore.

Peronospora trifoliorum, De Bary. Forming dense, broadly effused greyish-lilac patches; conidiophores tufted, crowded together at the base, 300—450 μ long, 6—7 times forked above, rarely branching in threes, primary branches almost straight, secondary branches spreading, and more or less curved, ultimate branchlets curved; conidia broadly elliptical, 18—20 × 15—20 μ, tip very blunt and rounded, pale dingy lilac; oospores globose, wall smooth, brown, 24—38 μ diam.

Syn. *Peronospora sphaeroides*, W. G. Sm.
Peronospora grisea, var. *trifolii*, Rabenh.

Parasitic on the living leaves of leguminous plants, as *Trifolium, Ononis, Medicago, Melilotus, Lotus, Coronilla, Astragalus, Orobus*, etc.

Usually covering the entire under surface of the leaf, with a very delicate greyish film.

Peronospora grisea, De Bary. Forming dense, velvety, greyish-violet patches; conidiophores tufted, 250—400 × 8—10 μ, 5—7 times forked above, branches tapering upwards, spreading, more or less curved, ultimate branchlets straight or curved; conidia elliptical, tip rounded and blunt, 20—30 × 15—22 μ, pale dingy lilac; oospore globose, brown, wall densely but very minutely warted, sometimes smooth, 35—46 μ diam.

Syn. *Botrytis grisea*, Unger.

Growing on the under surface of leaves of plants belonging to the order Scrophulariaceae, as *Veronica beccabunga, V. serpyllifolia, V. scutellata, V. arvensis, V. verna, V. triphylla, V. hederaefolia, V. anagallis*, etc.

Peronospora violae, De Bary. Forming dense, felt-like effused greyish-lilac patches; conidiophores tufted, about 300 × 8 μ, 3—7 times branched upwards, ultimate branchlets short, tapering, spreading; conidia elliptical, somewhat warted at the tip, 20—27 × 14—19 μ, pale lilac; oospore somewhat angularly globose, yellowish-brown.

Syn. *Peronospora effusa*, var. *violae*, Fuckel.

Parasitic on leaves of plants belonging to the order Violaceae, as *Viola tricolor, V. riviana, V. biflora*, etc.

Exceptional in having the tip of the conidium slightly apiculate.

Peronospora arborescens, De Bary. Forming dense, widely effused patches, at first white, then greyish-violet; conidiophores tufted, 300—800 × 10—12 μ, forked 6—10 times upwards, branches more or less wavy, spreading, becoming thinner upwards, ultimate branchlets slender, pointed, more or less curved; conidia subglobose, 15—24 × 15—20 μ, colourless or tinged lilac; oospores subglobose, wall brown, very minutely streaked, 25—35 μ diam.

Syn. *Botrytis arborescens*, Berk.
Peronospora papaveris, Tul.

Parasitic on the leaves of plants belonging to the order Papaveraceae, as *Papaver rhaeas, P. dubium, P. somniferum, P. argemones*, etc.

Often destructive to cultivated poppies, covering the entire under surface of the leaves with a pale dingy violet felt.

B. *Intermediae*

Peronospora effusa, Rabenh. Forming dense, effused greyish-lilac patches; conidiophores tufted, emerging through the stomata, 200—400 × 8—9 μ, 2—7 times forked upwards, ultimate branchlets thick, pointed, spreading and curved; conidia elliptical, with a short, distinct stalk, 25—35 × 15—24 μ, pale dingy lilac; oospore angularly globose, irregularly wrinkled, the wrinkles sometimes combining to form an indistinct and irregular network, 25—38 μ diam.

Syn. *Botrytis effusa,* Fres.
Peronospora chenopodii, Schl.

Parasitic on leaves belonging to the order Chenopodiaceae, as *Chenopodium album, C. muralis, C. glaucum,* C. *polyspermum, C. hybridum,* C. *bonus-henricus, Atriplex patula, A. nitens, A. hastata, A. rosea, Spinacia oleracea,* etc.

Usually forming broadly effused, pale lilac-grey patches on the under surface of the leaves. Sometimes proves to be very destructive to cultivated spinach.

Peronospora myosotidis, De Bary. Forming whitish or greyish, rather dense patches; conidiophores usually emerging through the stomata in pairs, slender, 230—600 × 7—10 μ, 6—9 times forked upwards, all the branches spreading, the upper ones slightly curved, the remainder straight; conidia broadly elliptical, 16—24 × 12—15 μ, tinged lilac; oospore globose, wall ornamented with raised ridges, combined to form a network, 28—34 μ diam.

Syn. *Peronospora cynoglossi,* Burr.
Peronospora asperuginis, Schr.

Parasitic on plants belonging to the order Boraginaceae, as *Myosotis arvensis,* also on species of *Lithospermum, Cynoglossum, Symphytum,* etc.

Peronospora viciae, De Bary. Patches dense, effused, whitish then pale pinkish-grey; conidiophores tufted, 400—700 × 9—11 μ, equally, rarely irregularly 6—8 times forked above, branches spreading, sometimes more or less curved, ultimate branchlets short, tapering to a point; conidia elliptical or broadly pear-shaped, 22—28 × 15—19 μ, pale dingy lilac; oospores globose, pale yellowish brown, wall ornamented with a raised, large meshed network, 28—32 μ diam.

Syn. *Botrytis viciae*, Berk.
Protomyces reticulatus, Sacc.

Parasitic on the leaves of leguminous plants as *Vicia sepium*, *V. hirsuta*, *V. tetrasperma*, *V. cracca*, *V. sativa*, *Pisum sativum*, *Lathyrus pratensis*, *Orobus tuberosa*, *Melilotus officinalis*, *Ononis spinosa*, etc.

Peronospora affinis, Rossm. Patches dense, effused, greyish-lilac; conidiophores tufted, 250—300 × 9—11 μ, 5—7 times forked above, lower branches spreading, sometimes curving inwards, or towards each other; conidia elliptical, 20—27 × 12—18 μ, pale lilac; oosphere with a thick, yellowish wall; oospore subglobose, wall yellowish-brown, smooth, 32—35 μ diam.

Parasitic on leaves of plants belonging to the order Fumariaceae as *Fumaria officinalis*.

Peronospora lamii, A. Braun. Forming lax or dense, effused, greyish-lilac patches; conidiophores often produced singly, 250—650 × 8—9 μ, 5—7 times forked above, branches tapering upwards, more or less curved, ultimate branches often elongated and tapering to a point; conidia broadly elliptical, with a short, persistent stalk, 17—24 × 15—20 μ, pale dingy lilac; oospores subglobose, with a thin, smooth, brown wall, 28—30 μ diam.

Syn. *Peronospora calaminthae*, Fuckel.

Parasitic on the under surface of leaves of plants belonging to the order Labiatae, as *Lamium album*, *L. purpureum*, *L. rubrum*, *L. amplexicaule*, *L. maculatum*, *Salvia pratensis*, *Stachys palustris*, *Thymus* and *Calamintha*, etc.

Often forming broadly effused felt-like patches on the under surface of the leaves.

Peronospora sordida, Berk. Forming dense, effused, dingy greyish-lilac patches; conidiophores tufted, 350—550 × 8—10 μ, lower unbranched portion elongated, dividing above into 3—8 main branches, which become 2—4 times irregularly forked, often more or less curved downwards, ultimate branchlets short, tapering to a point, curved; conidia broadly elliptical, 24—28 × 18—22 μ, with a very faint lilac tinge, or colourless.

Parasitic on the under surface of the leaves of plants belonging to the order Scrophulariaceae, as *Scrophularia aquatica*, *S. nodosa*, *S. altaica*, *Verbascum thapsus*, *V. blattaria*, *V. thapsiforme*, *V. nigrum*, *V. virgatum*, *Digitalis purpurea*, etc.

Peronospora sparsa, Berk. Patches of mildew whitish, indistinct; conidiophores scattered, slender, 250—400 × 6—8 μ, divided into 3—5 primary, ascending branches, which become 2—4 times irregularly forked, sometimes the branches are slightly curved and bent backwards, ultimate branchlets generally curved and tapering to a point; conidia broadly elliptical, tip rounded, 17—22 × 14—18 μ, almost colourless.

This species occurs on the leaves of plants belonging to the order Rosaceae, and so far only on the genus *Rosa*.

It sometimes proves very destructive to roses, more especially when grown under glass.

C. *Undulatae*

Peronospora ficariae, Tul. Forming broadly effused, dingy white, then greyish-lilac patches of mildew; conidiophores tufted, 200—400 × 8—10 μ, 5—7 times equally or unequally forked, the last two orders of branches often curved or wavy, ultimate branchlets often tapering to a point; conidia broadly elliptical, 20—29 × 15—20 μ, pale dingy lilac; oospores angularly globose, wall brown, almost or quite smooth, 30—35 μ diam

Syn. *Peronospora grisea*, Unger.
Peronospora myosuri, Fuckel.

Parasitic on leaves of plants belonging to the order Ranunculaceae, as *Ranunculus ficaria*, *R. acris*, *R. flammula*, *R. auricomus*, *R. bulbosus*, *R. repens*, etc.

Often covering the entire plant, and producing fruit everywhere, except on the roots and flowers.

Peronospora urticae, De Bary. Forming greyish-lilac patches of mildew; conidiophores 200—300 × 8—9 μ, 4—6 times forked above, branches wavy, ultimate branchlets tapering to a point, often curved downwards; conidia broadly elliptical or subglobose, 20—28 × 17—22 μ, tip rounded, pale dingy lilac; oospores subglobose, brown, smooth, 21—32 μ diam.

Parasitic on plants belonging to the order Urticaceae, as *Urtica dioica* and *U. urens*.

Forming small greyish-lilac patches on the under surface of the leaves.

Peronospora alta, Fuckel. Forming greyish-violet, velvety patches; conidiophores generally solitary, rarely in tufts of 2—3, slender, 200—600 × 8—9 μ, 6—8 times forked upwards, branches spreading, more or less curved,

ultimate branchlets tapering to a point, unequal; conidia elliptical or broadly pear-shaped, 24—30 × 16—20 μ, tinged lilac; oospores unknown.

Parasitic on leaves of plants belonging to the order Plantaginaceae, as *Plantago lanceolata* and *P. major*.

ERYSIPHACEAE, Lév.

Parasitic on phanerogamic plants; vegetative mycelium colourless, superficial, that is, on the surface of the host-plant, sending haustoria into the epidermal cells only (except in the genus *Phyllactinia*); mycelium septate, thin-walled, branched, interwoven to form a more or less evident superficial layer, which gives origin to erect chains of large, colourless conidia, or in some instances only a single conidium is present, supported on an erect conidiophore; perithecia originating from the superficial mycelium, sessile, indehiscent, at first colourless, gradually passing through yellow to dark brown or blackish when mature, the outer cells of the wall giving origin to outgrowths called appendages, which may more or less resemble the mycelium, or may assume definite and characteristic shapes; asci one or several in a perithecium, usually more or less globose, more rarely cylindrical, 2—8-spored; spores 1-celled, colourless, paraphyses absent.

The most pronounced feature of the present group consists in the indehiscent perithecium, that is, there is no definite mouth or opening through which the spores escape at maturity, consequently they are only liberated when the perithecial wall decays, or becomes ruptured. Another constant feature is the presence of certain outgrowths from the wall of the perithecium, these sometimes are but little different in appearance from the ordinary mycelium springing from the base of the perithecium; in other instances, however, the appendages assume very definite and characteristic forms, which are of value in the determination of genera and species. In all the genera, with the exception of *Phyllactinia* and one species of *Erysiphe*, the superficial mycelium sends haustoria into the epidermal cells of the host-plant only, whereas in the last-named genus, the superficial mycelium sends hyphae through the stomata into the intercellular spaces of the leaf, these hyphae send haustoria into the adjoining cells.

All the species are true parasites, mostly forming delicate white mildewed patches on the leaves and other parts of living plants, and many prove very injurious to cultivated

plants. The entire group is often spoken of as powdery mildews, on account of the dense masses of conidia that are produced, and rest on the white patches of mycelium, giving them the appearance of having been sprinkled with flour. These conidia are readily dispersed by wind, insects, etc., and infect adjoining plants. The conidial condition is well developed and constant in all species, but as a rule the conidia are so very similar in the different species, that they are of little or no value for the purpose of determining species, and it is only by infection experiments that their true nature can be ascertained, as they will only infect their own proper host-plants. The minute perithecia, at first yellow, then blackish, are readily seen with a pocket-lens, on the surface of the leaf resting on the superficial mycelium. Sections of the leaf, at those points where the mycelium is located, will be necessary to show the structure of the haustoria in the epidermal cells. The perithecia should be picked off the leaf, and placed in a drop of water on a slide, and covered with a cover-glass, when the character of the appendages can be studied, and if the perithecia are gently crushed, the asci are pressed out, when their shape, size, and number of spores contained, can be studied.

At one time the connexion between the white, conidial condition of the fungus, and the ascigerous stage was not suspected, and the white conidial stage was considered as a genus by itself, and was known as *Oidium*.

Perhaps no other family of fungi, until the appearance of Salmon's exhaustive monograph, was in such a state of hopeless confusion, as proved by the synonyms, which are almost legion. The determination of species, or the creation of new ones, being apparently determined more by the host-plant, than by morphological characters presented by the fungus itself. Nevertheless, we find that if a given species of fungus is not confined to a single host-plant, it is at least generally confined to allied host-plants, in which case the host-plant at least gives a clue to the species of fungus present, this clue, however, must not be accepted as final, and the fungus itself must be examined before its name can be correctly determined.

ERYSIPHACEAE

Parasitic on living plants ; mycelium slender, colourless ; conidial form of reproduction, along with the mycelium produced on the surface of the host-plant ; ascigerous form

of fruit also superficial on the host-plant; perithecia usually furnished with differentiated appendages, mouthless.

KEY TO THE GENERA

Ascus solitary; appendages springing from the apex, or forming an equatorial zone round the perithecium. *Podosphaera.*

Ascus solitary; appendages springing from the base of the perithecium, somewhat resembling the mycelium in appearance . . . . . *Sphaerotheca.*

Asci several; appendages curled or uncinate at the tip, generally simple . . . . . *Uncinula.*

Asci several; appendages usually repeatedly forked at the tip . . . . . *Microsphaera.*

Asci several; appendages straight, simple, much swollen at the base . . . . . *Phyllactinia.*

Asci several; appendages simple or irregularly branched, more or less resembling the mycelium, with which they are mixed . . . . . *Erysiphe.*

NOTES ON THE GENERA

Microscopic examination is absolutely necessary, even for the discrimination of genera in the present family.

PODOSPHAERA

The points to be kept in view are: a single ascus in the perithecium, and the appendages springing from the upper part of the perithecium. *Sphaerotheca* is the only other genus having only one ascus in the perithecium, but is distinguished at once by the vague or ill-defined appendages springing from the base of the perithecium, and usually mixed with the mycelium. *P. leucotricha* is the species most likely to be met with first by the student, as it is so very frequent on apple trees, covering the terminal clusters of leaves with the white, mealy, oidium form of the fungus.

SPHAEROTHECA

The single, 8-spored ascus contained in the perithecium, and the ill-defined appendages mark the present genus. So far as at present known, the presence of thin flat plates or rods in the cell-contents of the conidia, are confined to this genus; the detection of these bodies requires careful microscopic manipulation, but the point is a matter of some economic importance, as it enables the investigator to determine whether he is dealing with the European or with

the American gooseberry mildew, as both are white at first, and otherwise practically indistinguishable.

Two serious epidemics are produced by species belonging to this genus. *S. pannosa* causes rose mildew, and *S. mors-uvae*, the still more serious American gooseberry mildew.

UNCINULA

The perithecium containing several asci, and the unbranched appendages with hooked or curled tips, stamp the present genus. The species occur chiefly on the leaves of trees, poplars, willows, alders, blackthorn, etc., and are not responsible for any serious disease of cultivated plants.

MICROSPHAERA

Asci several in the perithecium; appendages with usually many times forked tips, the branches forming an elaborate and highly ornamental structure, not met with in any other genus. *M. grossulariae* is the cause of the European gooseberry mildew, which sometimes proves injurious to cultivated gooseberry bushes, but by no means to the same extent as that caused by *Sphaerotheca mors-uvae*, which has recently over-run this country, and Europe generally.

ERYSIPHE

Perithecia containing several asci; appendages vague and without any definite branching at the tip, usually intermixed with the mycelium. *Sphaerotheca* has somewhat similar appendages, but differs in having one ascus in the perithecium. In some species the spores are only formed in the ascus after the host-plant has been dead for some time.

PHYLLACTINIA

Perithecia large, containing many asci; appendages straight, spine-like or needle-like, with a large swollen base, separate this genus from every other. Not uncommon on leaves of hazel, sycamore, alder, etc.

PODOSPHAERA, Kunze

Perithecia subglobose, blackish when mature; only one ascus present, subglobose, 8-spored; spores elliptical, colourless; appendages springing from the tip of the ascus, or from the middle or equatorial region, forked at the tip, sometimes coloured.

Podosphaera agrees with *Sphaerotheca* in only having one ascus in the perithecium, but differs in the appendages

being branched in a definite manner at the tip, and in not originating from the base of the perithecium.

KEY TO THE SPECIES

Appendages of two kinds, one kind springing from the tip of the perithecium, long, and generally unbranched; a second kind springing from the base of the perithecium, and only slightly differing from the mycelium. *leucotricha.*

Appendages springing more or less equatorially from the perithecium, 2–4 times forked at the tip, tips of the ultimate branchlets swollen . . . . *oxyacanthae.*

Appendages springing from the tip of the perithecium, very long, wavy, tips 2–3 times forked, branchlets recurved . . . . . *schlechtendalii.*

Podosphaera oxyacanthae, De Bary. Growing on both sides of the leaves, mycelium sometimes forming persistent white patches, at others soon disappearing; perithecia crowded or scattered, 64–90 μ diam.; appendages spreading, originating more or less equatorially, or nearer to the top of the perithecium, very variable in number and length, 4–30 in number, and from 1–10 times as long as the diameter of the perithecium, base brownish, tip 3—4 times forked, ultimate branchlets knobbed at the tip; ascus very broadly pear-shaped, or subglobose, 58—90 × 45—70 μ; spores normally 8, sometimes fewer, variable in size, 18—30 × 10—17 μ.

Syn. *Erysiphe oxyacanthae,* D.C.
Podosphaera myrtillina, Kze. and Schm.
Podosphaera clandestina, Lév.

Parasitic on plants belonging to Rosaceae and to Ericaceae, as *Crataegus, Amelanchier, Prunus, Spiraea, Vaccinium* etc., var. *tridactyla* (Wallr.). Perithecia 70–150 μ diam.; appendages 2–8, usually about 4, 1—8 times as long as the diameter of the perithecium, from the top of which they spring in a tuft, and are more or less erect, 3—5 times forked at the tip, ultimate branchlets knobbed.

Differs from the typical form in the few appendages springing in a cluster from the top of the perithecium, and in being more or less erect.

Syn. *Alphitomorpha tridactyla,* Wallr.
Podosphaera kunzei, Lév.

Parasitic on species of *Prunus, Pyrus,* and *Spiraea.*

Podosphaera leucotricha, Salmon. Mycelium on both surfaces of leaves, thin, broadly effused, persistent; perithecia crowded, rarely scattered, 75—76 μ diam.; appendages of two kinds, one kind springing in a tuft from the top of the perithecium, few in number, coloured below, long, simple or sparingly forked near the tip; the second kind springing from the base of the perithecium, brown, wavy, simple or vaguely branched; ascus oblong or subglobose, 55—70 × 44—50 μ; spores 22—26 × 12—14 μ.

Syn. *Sphaerotheca leucotricha,* Ellis and Everh.
Sphaerotheca mali, Burr.

Parasitic on species of *Pyrus.* This is a very destructive parasite to the apple (*Pyrus malus*), in many parts of the world, often attacking seedlings and young trees. In this country, however, it proves most injurious to full-grown apple trees, where its oidium condition covers the clusters of leaves at the tips of the twigs with a dense, white, powdery coat, which prevents the further growth in length of the shoot. I first found the perithecia in this country on the branches of some suckers of an apple tree at Mortlake. They have since been found on the leaves, and also on the fruit, but are not generally sufficiently abundant to account for the widespread occurrence of the oidium stage every season, and it is believed that the mycelium of the fungus hibernates between the bud-scales, and gives rise to the white oidium condition of the fungus. The oidium or conidial stage of the fungus is known in this country as *Oidium farinosum,* Cooke.

Podosphaera schlechtendalii, Lév. Occurring on both surfaces of the leaves, mycelium soon disappearing; perithecia scattered, subglobose, 78—90 μ diam.; appendages 5—12, unequal in length, 6—12 times as long as the diameter of the ascus, springing from the top of the perithecium, and forming a long, weak, wavy tuft, 2, rarely 3 times forked at the tip, branchlets recurved, terminal ones knobbed; ascus subglobose, 76—84 × 68—74 μ; spores 8, 23—28 × 13—15 μ.

Parasitic on leaves of plants belonging to the order Salicaceae. *Salix alba,* and *S. viminialis.*

There is no direct evidence of the occurrence of this species in this country. It has been found in France.

SPHAEROTHECA, Lév.

Perithecia subglobose, ascus solitary, containing 8 spores; appendages not well differentiated from the mycelium,

springing from the base of the perithecium and spreading horizontally, simple or vaguely branched, often almost wanting.

The genus is well characterised by the presence of only a single ascus in the perithecium, and the vague appendages.

KEY TO THE SPECIES

Mycelium persistent, forming dense, white, felt-like patches, in which the perithecia are imbedded. *pannosa.*
Mycelium persistent, forming dense, brown, felt-like patches, in which the perithecia are imbedded. *mors-uvae.*
Mycelium forming thin patches, which usually soon disappear . . . . . *humuli.*

Sphaerotheca pannosa, Lév. Mycelium persistent, forming dense, whitish, satiny patches on the more persistent parts of the host-plant ; perithecia more or less immersed in the persistent mycelium, subglobose, blackish, about 100 μ diam. ; ascus broadly oblong to subglobose, 88—115 μ, averaging 100 × 60—75 μ ; spores 8, 20—27 × 12—15 μ.

Syn. *Podosphaera pannosa,* De Bary.

Parasitic on plants belonging to the order Rosaceae, as *Rosa canina, R. arvensis, R. damascena, R. glauca,* and many other species of *Rosa,* also on *Prunus persica.*

This fungus is very common on wild roses, and is also a source of constant anxiety to rose growers. The conidial condition forms a thin white, pulverulent layer on the young leaves, but it is on the young shoots, sometimes also on the fruit, that the mycelium forms dense, felt-like, whitish patches, on which the perithecia appear in due course.

Sphaerotheca humuli, Burr. Patches formed on both surfaces of leaves, mycelium white, usually soon disappearing, but at times persisting in white patches on the upper surface of the leaves ; perithecia scattered or densely crowded, 50—120 μ diam., appendages very variable in number and length, usually long and coloured, straight or contorted, sometimes almost absent ; ascus broadly elliptical to subglobose, 45—90 × 50 -72 μ ; spores 8, 20—30 × 12—18 μ, averaging 22 × 15 μ.

Syn. *Sphaerotheca castagnei,* Lév.

This fungus is parasitic on plants belonging to various orders of plants, as Rosaceae, Geraniaceae, Violaceae, Uritcaceae, etc. In this country it is best known as the very destructive hop mildew.

Var. *fuliginea,* Salmon. Perithecia about 50 μ in diameter, appendages usually short, pale brown, crooked, but

sometimes long and straight; spores 20—25 × 12—15 μ.

Parasitic on plants belonging to Compositae, Scrophulariaceae, Ranunculaceae, Labiatae, etc.

Sphaerotheca mors-uvae, Berk. and Curt. Mycelium persistent, at first white, then changing to a dingy brown colour, felt-like and readily peeled off the branches or fruit; perithecia gregarious, more or less immersed in the mycelium, 76—110 μ diam., appendages usually few in number, pale brown, short, and contorted, sometimes elongated; ascus elliptic-oblong to subglobose; spores 20—25 × 12—15 μ.

Syn. *Erysiphe mors-uvae,* Schwein.

Parasitic on species of plants belonging to the order Ribesiaceae, as various species of *Ribes*. In this country it is known as the American gooseberry mildew, and is a very destructive pest to the gooseberry (*Ribes grossularia*), and has also occurred sparingly on the red currant (*Ribes rubrum*). The disease first appears as a white mildew on the young leaves and shoots, afterwards the fruit is attacked, and more or less covered with a dense brown felt.

UNCINULA, Lév.

Perithecia globose or somewhat depressed; asci several, containing 2—8 spores; appendages usually simple, rarely once or twice forked, uncinate, that is, with a curl at the tip.

The genus is readily distinguished by the uncinate tips of the appendages.

KEY TO THE SPECIES

A. *Appendages branched* . . . . . *aceris.*

B. *Appendages simple* (=unbranched).

Appendages crowded, 100—150. Parasitic on species of *Populus* and *Salix* . . . . . *salicis.*

Appendages variable in number, 12—60, rough. Parasitic on species of *Prunus*. . . . . *prunastri.*

Appendages few, generally about 15.

Parasitic on *Ulmus*. . . . . *clandestina.*

Parasitic on *Vitis*. . . . . *necator.*

Uncinula aceris, Sacc. Mycelium soon disappearing, or persisting as a thin, spreading film; perithecia scattered or clustered, 120—225 μ diam.; appendages numerous, usually once forked, each branch sometimes again forked,

a few may be quite simple; asci 4—12; spores usually 8, 22—26 × 13—15 μ.

Syn. *Uncinula bicornis*, Lév.

Readily distinguished from all other species by the forked appendages.

Parasitic on the leaves of the sycamore (*Acer pseudoplatanus*), *Acer campestre*, and other species of *Acer*.

Uncinula salicis, Winter. Mycelium usually soon disappearing, sometimes forming white persistent patches; perithecia usually much crowded, sometimes scattered, averaging 135 μ diam., appendages usually crowded, 100—150, sometimes fewer, simple and curled at the tip; asci variable in number, 4—14; spores 4—6, 20—26 × 10—15 μ.

Syn. *Erysiphe adunca*, Link.
Uncinula adunca, Lév.

A variable species as regards the size of the perithecium, but distinguished by the numerous, simple appendages which are not much longer than the diameter of the perithecium.

Parasitic on the leaves of various species of poplar, as *Populus balsamifera*, *P. alba*, *P. tremula*, etc., also on species of willow, as *Salix aurita*, *S. capraea*, *S. nigra*, *S. cinerea*, etc.

Uncinula prunastri, Sacc. Mycelium soon disappearing; perithecia gregarious or scattered, variable in size; appendages very variable in number, 12—60, becoming enlarged towards the curled tip, simple; asci 7—18; spores 5—7, 16—20 × 8—10 μ.

Syn. *Uncinula wallrothii*, Lév.

A variable species as regards the size of the perithecium and the number of appendages. Some forms approach *U. clandestina*, which differs in the ascus containing only 2—3 spores.

Parasitic on the leaves of species of *Prunus*.

Uncinula clandestina, Schroet. Mycelium usually soon disappearing, or persisting as a very thin, white film; perithecia crowded in small patches, or scattered, 85—115 μ diam.; appendages few, 9—30, usually about 15, simple, usually rough near the base, becoming swollen at the curled tip; asci 3—5, usually 4; spores 2, or rarely 3, 30—34 × 15—18 μ.

Syn. *Uncinula bivonae*, Lév.

Parasitic on the leaves of species of elm (*Ulmus campes-*

ris), and *U. montana*. Distinguished by the few, club-shaped appendages, and the 2-spored ascus.

Uncinula necator, Burr. The very thin, effused mycelium usually more or less persistent; perithecia scattered, 70—128 μ diam., averaging 98 μ; appendages variable in number and length, 7—32, brown in the lower half, wavy when long, tip usually with a considerable curl; asci 4—9; spores 4—7, 18—25 × 10—12 μ.

Syn. *Erysiphe tuckeri*, Berk.
Uncinula spiralis, Berk. and Curt.

In England this species is known as the "Grape mildew." The oidium form was first described by Berkeley as *Oidium tuckeri*, in 1847, found on grapes from the neighbourhood of Margate. The ascigerous form has not yet been collected in this country, although it has been found sparingly in France, and is very abundant in the United States both on cultivated and wild vines (*Vitis*), also on species of *Ampelopsis*,

MICROSPHAERA, Lév.

Perithecia globose or somewhat depressed; asci several, containing 2—8 spores; appendages, much branched in a definite manner at the tip (almost simple in one species).

The species are readily recognised by the beautifully branched tips of the appendages.

KEY TO THE SPECIES

Parasitic on species of *Berberis* . . . . *berberidis.*
Parasitic on species of *Euonymus* . . . . *euonymi.*
Parasitic on species of *Astragalus* . . . . *astragali.*
Tips of appendages more or less closely 3—6 times forked, tips of ultimate branches recurved. Parasitic on many different hosts . . . . . *alni.*
Parasitic on species of *Lycium* . . . . *mougeotii.*
Parasitic on species of *Vicia* . . . . . *baumleri.*
Parasitic on species of *Ribes* . . . . . *grossulariae.*

Microsphaera berberidis, Lév. Mycelium usually soon disappearing, or sometimes persisting in thin white patches; perithecia usually scattered, rarely in crowds, 90—125 μ diam.; appendages 5—20, up to 2½ times as long as the diameter of the perithecium, tips regularly 4 times forked, branching rather close, ultimate branchlets not recurved; asci 4—9; spores 3—6, usually 4, 18—22 × 9—11 μ.

Syn. *Erysiphe penicillata*, Link.

Differs from *M. grossulariae* in the longer appendages, and in the somewhat smaller spores.

Parasitic on the leaves of barberry (*Berberis vulgaris*), and on those of *Berberis* (*Mahonia*) *aquifolium*.

Microsphaera euonymi, Sacc. Patches of mycelium usually on the under surface of the leaves, generally soon disappearing; perithecia usually more or less crowded; appendages 6—14, 2—5 times as long as the diameter of the perithecium, tips 3—5 times forked, ultimate branchlets usually straight; asci 3—7; spores 3—5, 20—23 × 10—12 μ.

Syn. *Microsphaera comata*, Lév.

Marked by the weak, long appendages becoming tufted together and lying on the leaf.

Parasitic on the leaves of *Euonymus europaeus* and *E. verrucosus*.

Microsphaera astragali, Trev. Mycelium usually soon disappearing; perithecia usually crowded, rarely scattered, 95—146 μ diam.; appendages 5—18, 4—10 times as long as the diameter of the perithecium, rather weak, wavy, forming a tuft, tip simple, or once or twice forked; asci 5—12; spores 3—6, usually 4, 20—23 × 10—12 μ.

Syn. *Microsphaera holosericea*, Lév.

Parasitic on the leaves of *Astragalus glycyphyllos*, and other species of *Astragalus*.

Microsphaera alni, Salmon. Mycelium sometimes soon disappearing, at other times persistent and effused; perithecia scattered or crowded, 66—110 μ diam.; appendages very variable in number and length, 4—26, usually about 1½ times as long as the diameter of the perithecium, tips more or less closely 3—6 times forked, ultimate branches always curved backwards; asci 3—8; spores 4—8, 18—23 × 10—12 μ.

Syn. *Microsphaera hedwigii*, Lév
Microsphaera penicillata, Lév.

Salmon says this is the most variable species of the Erysiphaceae, and I quite believe it, he has devoted 27 pages to the elucidation of this species and its varieties, notwithstanding which, I am by no means certain that I have grasped the essential features of the species, and must be content to attribute to it, any *Microsphaera* found parasitic on species of *Alnus* or *Betula*.

Microsphaera grossulariae, Lév. Mycelium often soon disappearing, or more or less persistent on the upper surface of the leaves; perithecia scattered or crowded, variable in size, 60—130 μ; appendages 5—22, 1—1¾ times the diameter of the perithecium in length, tips 4—5 times closely and regularly forked, branches of the first and second orders very short, tips of the ultimate branches not recurved; asci 4—10; spores 4—6, rarely only 3, variable in size, 20—28 × 12—16 μ.

Syn. *Podosphaera grossulariae,* Quél.

Parasitic on the leaves, rarely on the fruit, of the gooseberry (*Ribes grossularia*). Sometimes proves injurious, causing the leaves to die and fall early in the season, it is, however, not nearly so injurious as the American gooseberry mildew, *Sphaerotheca mors-uvae.*

Microsphaera mougeotii, Lév. Mycelium effused, thin, more or less persistent; perithecia usually on the upper surface of the leaves, somewhat gregarious or scattered, 115—170 μ diam.; appendages very numerous, densely crowded, 2—3 times forked at the tip, branching loose, irregular and spreading, ultimate branchlets not recurved; asci 10—18; spores 2, 20—24 × 12—15 μ.

Syn. *Microsphaera lycii,* Sacc. and Roum.

Distinguished from all other species of *Microsphaera* in the densely crowded, widely spreading branches of the tips of the appendages, and the 2-spored asci.

Parasitic on the leaves of the so-called "Tea-tree," *Lycium barbatum,* amd on other species of *Lycium.*

Microsphaera baumleri, P. Magn. Mycelium soon disappearing, or more or less persistent, mostly on the under surface of the leaves; perithecia in crowded patches, 80—150 μ diam.; appendages 8—20, 4—6 times as long as the diameter of the perithecium, soft, and forming a tuft when mature, tip about 3 times forked, branching loose, irregular, ultimate branchlets not recurved; asci 4—12; spores 4—8, 20—22 × 10—12 μ.

Syn. *Microsphaera marchica,* P. Magn.

Parasitic on leaves of *Vicia sylvatica.*

This is our rarest species included in the Erysiphaceae. It has only been recorded once, being detected by Salmon, in the Kew herbarium, called *Erysiphe communis,* on *Vicia sylvatica,* from Scotland.

PHYLLACTINIA, Lév.

Perithecia large, globose or depressed; appendages springing from the equatorial region of the perithecium, simple, rigid and spine-like, with a swollen base; asci many, 2-, rarely 3-spored.

Marked by the straight, simple appendages, furnished with a much swollen base. A dense mass of branched structures are present at the tip of the ascus.

Phyllactinia corylea, Karst. Mycelium often soon disappearing, sometimes more or less persistent, generally on the under surface of the leaves; perithecia generally scattered, large, more or less flattened, 140—170 μ diam., sometimes larger; appendages equatorially situated, 5—18, rarely more, 1—3 times as long as the diameter of the perithecium, straight, rigid, colourless, with a hollow, much swollen base; tip of perithecium covered with a dense mass of outgrowths from the cells of the perithecium, each stalk or outgrowth is terminated by a brush-like tuft of slender branches; asci 5—45, subcylindrical or broadly oblong, 2-, rarely 3-spored; spores variable in form and size 30—42 μ, smaller when 3 are present.

Syn. *Erysiphe guttata,* Fries.
Phyllactinia guttata, Lév.

The fungus grows on numerous different kinds of plants, as species of *Acer, Alnus, Corylus, Berberis, Angelica, Buxus, Fagus,* etc.

Salmon points out that the function of the curious outgrowths from the tip of the perithecium, is to anchor or fix down this structure when it turns upside down on the leaf, by becoming mucilaginous.

ERYSIPHE, D.C.

Perithecia globose or depressed; asci several, 2—8-spored; appendages without any definite branching at the tip, simple or irregularly branched, generally more or less like the mycelium and mixed with it, sometimes almost or quite absent.

Distinguished by the vague appendages, which more or less resemble the mycelium. Differing from *Sphaerotheca,* which also has somewhat similar appendages, by having more than one ascus in the perithecium.

KEY TO THE SPECIES

* *Spores normally 2 in an ascus.*

Haustoria lobed; spores produced in the ascus on the *living* host-plant . . . . . *galeopsidis.*

Haustoria not lobed; spores not produced in the ascus on the *living* host-plant . . . . . *cichoracearum.*

** *Spores more than two in an ascus.*

Parasitic on grasses . . . . . *graminis.*

Parasitic on species of *Cornus.* . . . . . *tortilis.*

Parasitic on *Polygonum, Achillea, Aconitum,* and numerous other plants, but not on *Cornus,* nor on grasses. *polygoni.*

Erysiphe gaelopsidis, D.C. Mycelium soon disappearing or somewhat thin and persistent; haustoria distinctly lobed; perithecia scattered or gregarious; appendages variable, mixed with the mycelium; asci rather numerous; spores 2 in number, not produced in the asci on the living host-plant, but the year following on the dead plant, averaging 20 × 12 μ.

Syn. *Erysiphe lamprocarpa,* Kickx.

Parasitic on the leaves of various labiate plants, as *Galeopsis, Ballota, Galeobdolon, Stachys,* etc.

Characterised by having lobed haustoria, and the absence of spores on the ascus on the living plant.

Erysiphe cichoracearum, D.C. Mycelium usually soon disappearing, sometimes persisting, usually white, rarely tinged pink; perithecia gregarious or scattered, 80—140 μ diameter; appendages very variable, usually vaguely branched and interwoven; asci about 10—15; spores 2, rarely 3, 20—28 × 12—20 μ, averaging 24 × 14 μ.

Syn. *Erysiphe lamprocarpa,* Kickx.
Erysiphe Linkii, Lév.
Erysiphe Montagnei, Lév.

Agreeing with *E. galeopsidis* in having 2 spores in the ascus, but differing in the larger spores.

Parasitic on numerous plants belonging to many different orders, as *Artemisia, Achillea, Ballota, Campanula, Cichorium, Crepis, Galium, Hieracium, Solanum,* etc.

Erysiphe graminis, D.C. Mycelium more or less persistent, forming whitish patches, often becoming tinged brown or grey; perithecia scattered or gregarious, depressed large, 135—280 μ diam.; appendages vague and rudimentary; asci numerous, 9—30; spores 8, rarely 4,

20—23 × 10—13 μ, rarely produced on the living host-plant.

Parasitic on the leaves of various grasses, as species of *Agropyron, Agrostis, Hordeum, Phleum, Poa, Festuca*, etc.

Erysiphe tortilis, Fries. Mycelium thin, effused, soon disappearing, mostly on the under surface of the leaf; perithecia very much crowded as a rule, sometimes scattered, 65—110 μ diam.; appendages very long, 10—20 times as long as the diameter of the perithecium, 8—20 or more in number, wavy, brown, becoming more or less erect and forming a tuft, weak; asci 2—5, usually 4; spores 4—8, usually 8, 20—24 × 10—14 μ.

Readily distinguished by the long, weak, wavy appendages, which form a tuft over the perithecium.

Parasitic on the leaves of *Cornus sanguinea* and other species of *Cornus*.

Erysiphe polygoni, D.C. Mycelium variable, thin and effused, or forming dense patches; perithecia usually scattered, rarely crowded, 65—180 μ, usually about 90 μ diam.; appendages very variable in number and length, always spreading horizontally, often interwoven with the mycelium; asci usually few, 2—8; spores 3—8, very rarely only 2, 19—25 × 9—14 μ.

Syn. *Erysiphe trifolii*, Grev.
Erysiphe communis, Grev.
Erysiphe martii, Lév.

Parasitic on plants belonging to many different orders, as *Achillea, Pisum, Vicia, Capsella, Asperula, Circaea, Convolvulus, Delphinium*, etc.

Often destructive to cultivated peas, beans, tares, etc.

PERISPORIACEAE

This family is allied to the Erysiphaceae, differing principally in having dark coloured or black mycelium, perithecia, and coloured spores, which are often more than 1-celled. Conidial stages are often present, but never of the oidium form, so characteristic of the Erysiphaceae. The family is essentially extra-European, and highly characteristic of tropical countries, where leaves more or less covered with jet-black, velvety patches, are quite as abundant as foliage covered with the snow-white oidium stage of the Erysiphaceae is in this country. There are but very few representatives of this family in Europe, and in this country the one representative of the genus *Thielavia* is

the most important from an economic standpoint, as it is not only interesting morphologically but also destructive parasites. A few other more or less imperfectly developed species are met with as black films on living leaves of various plants or trees. These are not parasites, but appear to exist on "honey-dew" secreted on the leaves by species of aphides or "green fly."

THIELAVIA. Zopf.

Endosporia. Forming delicate whitish mats; endospores produced in chains within a hypha, eventually escaping through the ruptured apex of the parent hypha.

Chlamydospores. Forming effused black patches; spores club-shaped, black, breaking up into their component cells.

Ascigerous stage. Perithecia membranous, globose, black; asci 8-spored, spores lenticular, coloured.

The only true representative of this genus is a very interesting fungus, and its component stages had been assigned to three distinct genera before its complete life-cycle was cleared up. The chlamydospore stage was first discovered and named by Berkeley, *Torula basicola*. Some years afterwards I discovered the endosporous form and established a new genus, *Malleosa*, for its reception, naming the fungus *Malleosa vorax*. Finally Zopf discovered the ascigerous form in Germany and connected it with the endosporous and chlamydospore stages.

The ascospore condition appears to be quite rare.

One of the most destructive of parasitic fungi, attacking seedling plants of very many different kinds. In this country it is most injurious to Asters and Sweet peas, but also attacks many kinds of weeds. On the Continent and in the United States it often proves very destructive to seedling tobacco plants.

Thielavia basicola, Zopf. Mass. *Bot. Brit. Fungi and Trees*, p. 160.

Endosporia. Forming delicate, white mould-like tufts on various plants at the ground level; endospores produced in chains within a hypha, escaping at maturity through the ruptured apex of the hypha cylindrical, ends truncate, ordinarily 22—28 × 4—6 μ.

Chlamydospores. Forming a black stain on plants at and near the soil; spores narrowly club-shaped, many septate, becoming black and breaking up into their component cells 10—25 × 5—7 μ.

Asci [illegible] Ascus roundish, globose, thick- and 8-spored; spore hyaline or pale, oval-shaped, colourless, 12 × 5 μ.

Syn. Endophytal form = *Aecidium* [illegible] Mont.

Chlamydospore form = *Uredo luxurians* Berk. and Broom.

The endophytal form, so-called because the mycelia are produced inside the nymphs, whilst the same is apparent as spores in an entire absence of a distinct mycelium on the surface of various weeds and cultivated plants. The chlamydospore mycelium of this phase of the fungus gradually increases larger in colour and grows outwards in rays to the black chlamydospores, which give to the root and lower portion of the stem of the host-plant a blackish or charred appearance, which results in its death. Finally the ascigerous stage is produced on the dead remains of the host-plant.

CAPNODIUM Mont.

Mycelium black superficial running over leaves and branches, penetrating somewhat thickly or rather sparsely simple or branched, variously elongated, septate or moniliform into a stout-like base following through the hairs of the peritheciums and pseudo-chlamydospores. Perithecia flask-shaped, superficially [illegible] septate, usually 1—4-celled, with short to [illegible] several septa in division, and more.

An imperfectly known genus. The species are often sterile or with very variable and apparently unlethal fruiting bodies.

Capnodium salicinum. Mont. Forming black more or less velvety patches on living leaves and stems; perithecia flask-shaped or horn-shaped, sometimes branched or twisted near the top, which becomes [illegible] pseudo-chlamydospores oval or broadly flask-shaped, [illegible] very short spores oblong with 3 transverse septa, constricted at the septa, [illegible] numerous, brown, 2—4-celled, [illegible] 12—15 × 4—5 μ.

Syn. *Fumago salicina* Pers. The perithecial form of the previous species.

The mycelium over-running the leaves is often modified in appearance that is it consists of more or less subglobose cells more constricted at the septa and therefore less evenly [illegible] a string of beads [illegible] transmitted light.

On living leaves of *Salix alba*, *S. caprea*, *S. viminalis*, *S. viridis* var. *S. tenuifolia*. Flowers open

Europe generally

Capnodium footii, Berk. and Desm. Forming rather small, circular, jet-black, more or less velvety patches on living leaves, mycelium consisting of interwoven moniliform hyphae; perithecia.?, bristle-shaped, surrounded at the base by somewhat hyaline, moniliform threads; asci and spores unknown.

Syn. *Fumago fagi*, Pers.

Common on living leaves of the beech (*Fagus sylvatica*) and many evergreen trees, also on living leaves of Dogs' mercury—(*Mercurialis perennis*).

A very unsatisfactory species.

Europe generally.

Capnodium elongatum, Berk. and Desm. Forming black, bristly or velvety patches on living leaves, mycelium interwoven, moniliform; perithecia elongated, mouth narrow and usually torn into shreds; asci ?; spores coloured, 2—3-septate, becoming muriform.

On living leaves of species of *Populus, Pyrus, Tussilago farfara.*

Europe generally, United States.

UREDINACEAE

The members of this family are all true parasites, and are popularly known as "rusts" and "cluster-cups." They are remarkable, even amongst the fungi, for the number and variety in form of spores or reproductive bodies possessed by many species, as also for the peculiar property, possessed by some, of passing one phase of their existence on a particular host plant, then migrating to another host-plant to complete the cycle of their development. All the species come under the category of "microscopic fungi," although the effects produced by some species on the host-plant render them sufficiently conspicuous.

The destruction caused to cultivated crops by these parasites has been known from early times, in fact, long before it was known that they were fungi, and unfortunately, even at the present day, but few practical methods for preventing their ravages, have been discovered. A somewhat detailed account of the various parts collectively constituting a member of this family, is necessary to form a clear conception of the mode of life followed.

Vegetative portion.

According to the popular idea, the visible portion of a fungus represents the entire plant; this is a mistake.

A mushroom, as generally understood, no more represents the entire fungus than an apple represents the entire apple tree. The mushroom is only the fruit of the fungus, as the apple is the fruit of the apple tree. It is known that when a mushroom-bed is prepared, the material called spawn has to be introduced before a crop of mushrooms can be produced. Now spawn consists of a dense mass of very fine, colourless threads, called *hyphae* (sing. *hypha*). These hyphae collectively constitute the *mycelium* and the mycelium in turn constitutes the vegetative portion of the fungus. Its function is to provide food for the growing plant, and is usually imbedded and hidden in the *matrix* or substance on which the fungus is growing, hence it is not generally observed, and the spore-bearing portion, which is produced on the surface, is considered as the entire fungus.

When a spore of one of the uredines alights on a suitable leaf under suitable conditions, it usually germinates within twenty-four hours, and emits a slender hypha, called the germ-tube ; after increasing in length for some time the tip of the germ-tube swells into a vesicle just over a stoma of the leaf. This vesicle is called the *appressorium*, into which the nucleus and contents of the spore pass. A slender tube from the appressorium then grows through the opening of the stoma into the air cavity, situated just underneath the stoma. In this cavity the slender tube passing through the stoma forms a second vesicle into which the contents of the first formed vesicle pass in turn, and from this vessicle originate the hyphae which spread in all directions between the cells of the leaf. The hyphae running between the cells of the leaf, give off at intervals short lateral branches, which pass through the walls of the cells of the leaf, for the purpose of absorbing food from the contents of the cells. These branches are called *haustoria* (sing. *haustorium*). Haustoria are of various forms. In some species they do not differ in form from ordinary hyphae, in others they are more or less lobed, or swollen at the tip. These details are sometimes of generic, or specific value. Haustoria are frequently difficult to see in a section, but if a dilute solution of eosin is run under the coverslip, the haustoria become stained a beautiful ruby-red colour.

Reproductive organs.

Nowhere else in the Vegetable Kingdom are so many

different kinds of reproductive organs met with as in the Uredinaceae, more especially in the genus *Puccinia*.

At this point it may be well to explain the meaning of the word *spore*. A spore is the equivalent of a seed in flowering plants, inasmuch as it is capable of germinating and producing a new plant; the seed of a flowering plant is furnished with an embryo or minute plantlet, whereas no such structure is present in the reproductive body of a fungus, hence it is not called a seed, but a spore; in some instances the term spore is used when the reproductive body is asexual in origin, in fact the term, spore, is often used for every reproductive body produced by fungi.

Pycnidia

The first form connected with reproduction at the commencement of the cycle of development in some species, is called a *pycnidium* (pl. *pycnidia*). The same structure is in some books called a *spermogonium* (pl. *spermogonia*). Pycnidia are minute, flask-shaped structures when seen in section, and usually occur in clusters on discoloured spots on living leaves, etc., the open mouths of the flask-shaped pycnidia projecting above the surface of the leaf, for the purpose of allowing of the escape into the air of the minute bodies produced in the interior of the pycnidia, which are called *spermatia* or *pycnospores*. Pycnidia possess no functional value as reproductive organs at the present day; the minute spermatia are supposed to represent the male fertilising element at some past period, when these fungi possessed a sexual mode of reproduction.

Aecidia

The first reproductive body of functional value at the present day is the *aecidium* (pl. *aecidia*). Aecidia usually appear early in the season, in more or less crowded clusters, on discoloured spots on living leaves or other parts of plants. The spores are produced in rows or chains, and consist of one cell, the oldest spore at the tip or apex of the chain becoming free at maturity, while young spores are produced at the bottom or *base* of the chain. In the most perfect forms of aecidia, numerous chains of spores are closely crowded side by side, and enclosed in a general envelope or *peridium* which is closed in the young stage, but becomes ruptured at maturity in a more or less stellate manner at the apex, the torn teeth usually bending outwards, and exposing the mass of orange or golden-yellow spores. Such structures are popularly known as "cluster-cups." The spores,

properly called *aecidiospores*, are usually globose or subglobose, with a colourless wall, which is generally ornamented with minute warts or spines, and is also furnished with thin places or *germ-pores*, through which the germ-tubes emerge on germination. When quite fresh, aecidiospores germinate freely in water, and the process can readily be studied in a hanging-drop. In the majority of species the aecidia are cup-shaped, and do not project much above the surface on which they are growing. Such forms were at one time considered as independent species, and were included in a genus called *Aecidium*. Other aecidia are considerably elongated, and cylindrical or horn-shaped, with a torn fringed opening at the tip when mature. Such forms once constituted the genera *Peridermium* and *Roestelia*. In other aecidia again, the peridium is almost or quite absent, but in such instances the presence of the spores originating in chains indicates their nature. On germination, aecidiospores produce one or more germ-tubes, which become branched and form mycelium directly.

Where several different forms of fruit enter into the life-cycle of a species, as previously stated, the aecidium stage appears first, and its spores infect the same, or some different kind of host-plant, the mycelium of which gives origin to the next fruiting stage, as uredospores or teleutospores. In some instances, however, several generations of aecidia may follow each other, resulting from infection by aecidiospores, before the next form in the cycle of development is produced, as in *Puccinia senecionis*, Lib. Aecidia that are the result of the germination of teleutospores—the most general method, have been called *primary aecidia*, whereas aecidia that result from the germination of aecidiospores are known as *secondary aecidia*.

Uredospores

When the cycle of forms in a fungus is complete, the *uredospore* stage follows the aecidium condition, resulting from infection by aecidiospores. Uredospores are produced in crowded heaps called *sori* (sing. *sorus*), which originate under the epidermis of the host-plant. When the spores are mature the epidermis is ruptured and the spores are exposed, and readily dispersed by wind, etc. In some species the sori are circular, in others elongated, and are usually more or less rusty or brown in colour. Uredospores consist of one cell, and are produced singly at the tips of slender hyphae, and are usually more or less globose, with

a brownish wall generally ornamented with warts or minute spines. Two to several pale round spots on the wall correspond to the points through which the germ-tubes spring when the spores germinate. These pale spots or germ-pores are sometimes of importance as specific characters, hence it is of importance to determine with accuracy the number present. They can be rendered more distinct by placing the spores on a glass slip in a small drop of equal quantities of lactic acid and water, which should be brought just to boiling-point for a moment over a spirit-lamp. When the wall of the spore is pale a dilute stain sometimes clearly defines the germ-pores. Bismarck brown answers this purpose well. Uredospores on germination produce germ-tubes which grow directly into mycelium. Uredospores, like aecidiospores are capable of germinating the moment they are mature, and as a rule do not retain their power of germination for a long period.

When the first crop of uredospores is mature, they are dispersed by wind and infect neighbouring host-plants, and this rapid production and dispersion of uredospores continues for a considerable period of time, usually as long as the host-plant continues to grow vigorously. For this reason, uredospores are often called *summer-spores*. The principal function of uredospores is to enable the fungus to extend its area of distribution, but, as the power of germination is usually limited in its duration, that is, uredospores will not germinate the season after their production, they are not capable of enabling the fungus to extend its period in point of time, or to survive from one year to another, or during that period of the year when the host-plant is absent. This function is reserved for the spore form to be considered next. Nowhere else in the plant world do we find such sharply-defined division of labour amongst reproductive bodies, as in certain fungi included in this group. The uredospores, as explained, enable the fungus to extend its area of distribution by being dispersed broadcast by wind and other agents, and being capable of infecting suitable host-plants at once. Such infections form new centres of disease, as within a week or ten days mature spores are ready for dispersion, which in turn act as centres from which spores are scattered. It will thus be realised that in those cases where a suitable host-plant is present in abundance, such as a field of wheat, if a single plant becomes infected, its spread, under favourable conditions may be very rapid, resulting in an epidemic, which

means a very severe attack. This is, broadly speaking, the extent of the usefulness of the uredospore stage to the fungus, at least, in countries where the host-plant is not growing all the year round, in the latter case, the uredospore condition may survive all the year round, as the only cause of its disappearance for a period of the year in this country is due to the absence of the host-plant in a growing condition. During certain mild winters, uredospores may frequently be found on grass and other plants throughout the season.

Teleutospores

Teleutospores are usually met with on the same host-plant as the *uredospore* stage, which it normally follows in the sequence of development of the different forms of fruit, when the full series is produced. As already stated, the uredospore stage continues to reproduce itself until the host-plant is past its prime of growth, when the same mycelium that produced uredospores now commences to produce teleutospores, which superficially resemble the sori of uredospores, but are darker in colour, or practically black, when a sorus is seen under a pocket lens. Teleutospores are produced singly at the tips of slender hyphae, and may consist of one or several cells. The wall is coloured, and frequently ornamented with warts, spines, a network of raised ribs, etc. Germ-pores are present in every cell composing the teleutospore. The one constant feature that readily separates teleutospores from every other kind of spore is the mode of germination. A thread or tube of limited length grows out of a germ-pore, furnished with two or three transverse walls or *septa* (sing. *septum*), thus dividing the tube into three or four joints or cells near the tip. From each joint or cell, a single minute spore is produced. The tube bearing these minute spores is named a *promycelium* and the minute spores it bears are known as *promycelium spores*, or sometimes *secondary spores*. In aecidiospores and uredospores, the germ-tubes produced on germination, on entering the host-plant grow on continuously and produce a mycelium, whereas in the case of a teleutospore, the product of germination is a tube of limited growth (promycelium), which bears promycelium spores, which alone can infect a plant, the teleutospore itself being incapable of so doing. A further point of importance in connexion with teleutospores is the fact that in the majority of species a period of rest is necessary before they can germinate. Most teleutospores remain in an unchanged

condition throughout the winter, and germinate the following spring, when their promycelium spores infect the proper host-plant, and give origin to the aecidium stage. For this reason teleutspores are often termed *winter-spores* or *resting-spores*. Their special function is to tide the fungus over that period of the year, when the host-plant is absent, in the case of annuals, or not in active growth, in the case of perennials. To the above general statements, there are, as might be expected, some exceptions, these will be dealt with in a later chapter. One such exception, however, may be dealt with at present. It has been stated that the teleutospores are borne singly at the tips of slender stalks or *pedicels*. To this there is an exception. One of the Uredinaceae not uncommon on living leaves of the houseleek and allied plants, presents all the usual features of an aecidium: there is present the outer protective envelope or peridium, enclosing spores produced in chains, and for ages this fungus was considered as an aecidium, the other stages of which had not been discovered. Fortunately some one germinated the spores of this supposed aecidium, and was much surprised to find that they gave origin to a promycelium, bearing promycelium-spores. Hence we have an example of teleutospores produced in chains. Other species belonging to this exceptional genus, called *Endophyllum*, have recently been described from Africa.

Mesospores

In addition to the foregoing spore forms, certain others called *mesospores* are met with in the same sorus as the teleutospores. These spores are one-celled, ovate or egg-shaped, and have the wall thickest at the tip or apex, as in most teleutospores. The cell-wall is coloured, and often warted. Such spores are considered by some as imperfect teleutospores, and are sometimes incapable of germination some, however, do germinate, and produce a promycelium which gives origin to promycelium-spores. Mesospores are present in *Puccinia pruni*.

Amphispores

In addition to normal uredospores, a second form superficially resembling uredospores, and called *amphispores*, occurs in some species. These agree with ordinary uredospores in being one-celled, in having more than one germpore, and in giving origin on germination to a germ-tube

which continues to grow indefinitely into ordinary mycelium. They differ in having a thicker wall than in uredospores, and in germinating only after a period of rest, in this respect agreeing with teleutospores. According to Arthur, an American mycologist, amphispores are mostly present in species inhabiting somewhat dry regions, and represent a resting form of uredospore. In *Puccinia vexans*, which is not, however, a British species, teleutospores and mesospores, and uredospores and amphispores are present.

Paraphyses

Certain hair-like, or club-shaped structures are met with surrounding the sori of some species, and are usually best developed in the sori of uredospores. Such are termed *paraphyses*. Their function is considered to be protective, by preventing desication, etc., of the spores after the epidermis of the host-plant has been ruptured.

Taking the teleutospore stage as the most perfect and highest form of spore production met with in the Uredinaceae, if we commence with the immediate product of infection set up by it through its promycelium-spores, and granting that all the stages are present, as in *Puccinia graminis*, the rust of wheat and other cereals, we have the following sequence of spore formations in the life-cycle: 1, pycnidia; 2, aecidium; 3, uredospore; 4, teleutospore; the spores of the last stage remaining passive during the winter, and germinating the following spring to commence the cycle anew. But in reality, comparatively few of the uredines possess the four forms of spore mentioned, any one stage or more may be omitted, without in any way interfering with the continuance of a species. For example in many parts of the world, where *Puccinia graminis* is rampant, the pycnidium and aecidium stages are left out of its cycle of development, without in any way interfering with its continuance as a scourge to agriculturalists. In many instances only the teleutospore stage remains, as in *Puccinia malvacearum*.

The following arrangement, adopted by Saccardo, of the species included in the genus *Puccinia*, where spore forms are most numerous, gives some idea as to the various stages that have dropped out during the gradual changes that have taken place since the time when presumably all the spore forms were present.

A. *Eu-Puccinia*. Pycnidia, aecidia, uredospores and teleutospores produced on a living host-plant; teleutospores

produced on a living host-plant ; teleutospores germinating only after a period of rest.

(1) *Auto-Puccinia.* Pycnidia, aecidia, uredospores and teleutospores produced on the same host-plant. Ex. *Puccinia galii.*

(2) *Hetero-Puccinia.* Promycelium-spores giving origin to aecidia on a different kind of host-plant from that on which teleutospores are produced. Ex. *Puccinia graminis.*

B. *Brachy-Puccinia.* Pycnidia, uredospores and teleutospores produced on the same host-plant, aecidia absent. Ex. *Puccinia obtegens* . . . . . (=*P. suaveolens*).

C. *Hemiphuccinia.* Uredospores and teleutospores produced on the same host-plant ; pycnidia and aecidia absent. Ex. *Puccinia polygoni.*

D. *Pucciniopsis.* Pycnidia, aecidia, and teleutospores produced on the same host-plant ; uredospores absent (or rarely a few mixed with the teleutospores). Ex. *Puccinia tragopogonis.*

E. *Micropuccinia.* Teleutospores only produced, germinating only after a long period of rest, on the dead host-plant. Ex. *Puccinia ribis.*

F. *Leptopuccinia.* Teleutospores only produced, germinating at once on the living host-plant. Ex. *Puccinia malvacearum.*

INFECTION EXPERIMENTS

From what has been stated, it is obvious that any one or more of the six known forms connected with reproduction, may drop out, or be omitted, without in any way preventing the remaining spore forms belonging to the species from continuing their existence. On the other hand, it is highly probable, that any one of the spore forms, excepting pycnidia, is capable of perpetuating itself continually.

As previously stated, aecidia, uredospore and teleutospore forms were at one time considered as representing three distinct genera. Many of these have now been linked up, or proved to be genetically connected. At the same time, even in this country, there are many aecidium and uredospore forms that are not connected with other spore forms. The only method of ascertaining whether such isolated forms, as we know them, are in reality genetically connected with other forms, is by infection experiments, and for this method there is no general rule ; that is, when the different spore forms grow on different host-plants, it does not follow that

because one spore form grows on a buttercup, that the second spore form should grow on another kind of buttercup, in fact just the opposite is usually the case, the two spore forms being parasitic upon host-plants that are widely separated from each other, from the standpoint of affinity or relationship, as botanically understood. For instance, take wheat rust—*Puccinia graminis*; the aecidium stage is parasitic on the leaves of the common barberry (*Berberis vulgaris*), a plant belonging to one of the two primary divisions of flowering plants, known as Dicotyledons, whereas the uredo- and teleutospore stages of the same fungus are parasitic on wheat and other grasses, which are included in the second great group of flowering plants, known as Monocotyledons.

For the purpose of gaining experience in infection experiments, it will perhaps be best to commence with those species where the two different host-plants are known. This, of course, will depend on infected plants occurring in the neighbourhood where the would-be experimenter is residing. Numerous species of *Puccinia* are mentioned in the systematic portion following, whose host-plants are fairly common everywhere. Now suppose an aecidium is met with that is not known to be connected with any other spore form, and it is determined to experiment with it; as already stated, there is no rule as to what other plant is likely to be its second host, providing it has one, consequently one or more kinds of vigorously growing plants, in the neighbourhood of the plant-bearing aecidia, should be infected. This is accomplished by depositing a few mature aecidiospores on a damp place on the leaf to be infected. If the infection proves successful, uredospores or teleutospores should appear at the points infected. When this result is obtained, it cannot be considered as completely proving that the fungus under consideration, grows on the two host-plants respectively. What remains to be done is to infect the plant bearing the aecidium with the spores produced on the plant infected with the aecidium spores, and if the aecidium stage results, it may then be safely assumed that the fungus in question has two spore forms produced on the two host-plants experimented upon.

In the case of teleutospores that only germinate after a period of rest, that is, the spring following their production, it is advisable to keep the plants bearing the teleutospores, throughout the winter, under what may be termed natural conditions, that is, they should be placed in the open,

exposed to the weather, and in the spring it would be well to place a few spores in a hanging-drop method of culture, to ascertain whether the spores are capable of germination, if so, the promycelial tubes, bearing promycelium spores, should be produced in about twenty-four hours. If the teleutospores germinate freely, they may be placed on the leaves to be infected.

BIOLOGICAL SPECIES

Species, as generally understood, depend entirely on morphological, that is, structural characters, but in addition to such species, there occur in the fungi, certain forms that have been termed biological or biologic species. Such forms do not differ from each other in structure, consequently cannot be separated from each other by structural characters. Biological species appear to have originated somewhat as follows: a given species of fungus originally grew on several different host-plants, but by degrees, those growing on one particular kind of plant became so accustomed to that host-plant, that they were unable to grow on any other kind of host-plant. During this process of becoming confined to one particular kind of host-plant, the fungus has undergone no structural change whatever; but, on the other hand, it has undergone what is called a physiological change; in other words, it has undergone such a change that it can only live on the food supplied, in addition to the general conditions essential to the well-being of the fungus, furnished by a particular host-plant. This is in reality the result of habit, or an acquired property, created perhaps in the first instance by accidentally growing on the same host-plant for several seasons in succession. As an example, *Erysiphe graminis* is parasitic on wheat, barley, oats, rye, and several wild grasses, but experiments have proved that the form of *E. graminis* on each of these host-plants, although not differing in the least in structural details, has become specialised or confined to its own particular host-plant, and the spores produced by the fungus on one host-plant cannot infect any other host-plant on which other biologic forms of *E. graminis* are parasitic.

Economic aspects

Some countries, England for instance, do not furnish statistics as to the loss caused to cultivated plants by fungi. The United States, Germany, Australia, etc., however, do so, and from most carefully compiled reports it is cal-

culated that the annual loss to cultivated plants throughout the world, caused by fungi alone, amounts at least to £250,000,000 sterling. The loss due to animal, mostly insect depradations, exceeds this amount.

According to the Prussian Statistics Bureau, the loss from rust of cereals alone amounted to £20,000,000 during one year. In the United States £3,000,000 represents the loss due to rust of wheat in one season. In Australia a dead loss of £2,500,000 was occasioned by the rust of wheat in a single season.

Heteroecism

This term implies that during different periods in the life-cycle of a fungus, it is parasitic upon two different host-plants. This remarkable phenomenon although not confined to members of the Uredinaceae, is most prevalent there and reaches its maximum in the genus *Puccinia*, although it is not confined to this genus. When a fungus, as in the great majority of instances, completes its entire development on one and the same host-plant, or matrix, it is termed *autoecious*. On the other hand, where a fungus lives during different periods of its development on two distinct host-plants, it is said to be *heteroecious*. As examples of heteroecious species, *Puccinia sylvatica* has its aecidial stage on the living leaves of the dandelion, and its uredo- and teleutospore stages on the living leaves of various sedges. The aecidiospores produced on the dandelion cannot directly infect another dandelion plant, but can infect the leaf of a sedge, and commence the uredo condition of the fungus. The uredospores produced on the sedge, can on the other hand, infect other sedges, and this continues so long as sedges are in active growth, but when the vitality of the sedge begins to wane, the mycelium that has been producing uredospores, now produces teleutospores. The teleutospores, unlike uredospores, cannot directly infect sedges, but after a period of rest, germinate the following season, and infect dandelion leaves, thus completing the cycle of development, and commencing a new cycle. *Puccinia graminis*, or wheat rust, when it passes through all the phases of its development, commences by producing its aecidial stage on living leaves of the barberry. The aecidiospores cannot infect other barberry leaves, but can infect the leaves of the wheat plant. This infection gives origin to the uredo stage, and the uredospores produced continue to infect other wheat plants throughout the grow-season, thus, as previously explained in connexion with the

uredo- or summer-spore form, enables the fungus to extend the area of its distribution. Towards the end of the season the production of uredospores gradually ceases, and teleutospores are produced from the same mycelium. It is not unusual to find a mixture of uredospores and teleutospores in the same sorus. In the spring the teleutospores germinate and give origin to secondary or promycelium spores, which infect young barberry leaves and give origin to the aecidium stage again.

When heteroecism was discovered by De Bary, it was hoped that a means of preventing the serious ravages caused by wheat rust had been discovered, by removing one of the two host-plants on which the fungus lived, hence a raid was made on barberry bushes. This idea was founded on the assumption that both host-plants were absolutely necessary for the continuance of the fungus, an assumption which did not prove to be correct, and it is now known that the aecidium stage can be left out without interfering with the continuance of the species. This is also true of other species. In *Puccinia graminis*, and in other species also, the uredo stage is capable of perpetuating itself, independent of any other form of spore, so long as its host-plant is vigorous, hence in warm countries where the host-plant can grow all the year round, the uredospore condition is always present, and even in this country uredospores are met with on wild grasses during the winter season. The succession of uredospores and teleutospores of *Puccinia graminis* from the same mycelium in the wheat plant, is in accordance with the view entertained by Klebs, who has demonstaated that the particular phase of development is determined by the chemical condition of the food, the amount of moisture present and the relative density of the medium in which the plant is growing. So long as the wheat plant is in active growth, its chemical and physical condition will remain practically unchanged, and thus the uredospore condition will continue, but when the period of ripening approaches, the chemical conditions will change, as will also the general texture of the plant, conditions which do not favour the further development of uredospores, but which, on the other hand, favour the formation of teleutospores.

Parasitism

Depending on the nature of the food, fungi are, broadly peaking, grouped under two headings: those that obtain heir food from dead organic matter, as dead wood, heaps

of dead leaves, etc., are called *saprophytes* ; those that derive their food from living plants, or less frequently from living animals, are termed *parasites*. As would be expected, there is no hard and sharp line between these two groups ; some fungi, so far as is known, can only exist as saprophytes ; others again, can only obtain their food from some living organism, and are sometimes spoken of as *obligate parasites*. Others again, that are generally saprophytes, possess the power of deriving their food from living plants, and thus become parasites for the time being. Such have been called *facultative parasites*.

The plant on which a fungus is parasitic is called the *host-plant*, the host being a compulsory one, and parasitic fungi gain an entrance to the host by different means. When a spore or conidium alights on a suitable living leaf, germination takes place if the necessary amount of moisture is present, hence plants are generally infected during the night, or during damp, dull days, a fact of some value in connexion with the prevention of diseases, it having been proved that plants covered with a screen, to prevent the deposition of dew during the night, remained practically free from infection, whereas plants of the same kind, not so protected during the night, become badly diseased.

The first product of a conidium, which usually consists of a delicate thread-like body, is called a *germ-tube*, this is produced on the surface of the leaf, and soon enters into the tissue of the leaf, either through a stoma, or directly through the epidermis, the tip of the germ-tube secreting an enzyme, or substance which enables it to penetrate the wall.

Once inside the leaf, the germ-tube soon produces a copious, branching mycelium which eventually produces the spores. Parasitism is an acquired habit on the part of fungi. It must be obvious to everyone that when the spores of fungi are dispersed by wind, insects, and other agents, such spores must necessarily alight on practically every kind of plant growing in the neighbourhood, but it is well known that a given parasitic fungus does not grow indiscriminately on every kind of plant. On the other hand, most fungi are confined to a few allied host-plants. Why ? Miyoshi, a Japanese botanist, has shown that if a very thin sheet of mica, through which a number of very minute holes have been pierced, is placed on the surface of gelatine, containing a substance suitable as food for a fungus, and fungus spores are then sown on the surface of the mica one of two things happens. Either the germ-

tubes pass through the minute holes into the prepared food, where they continue to grow, or they do not pass through the holes, but perish of hunger on the surface of the mica. An extended series of experiments proved that different fungi were attracted, or would grow into one particular kind of food only, and refused to enter into, and grow in any other kind of food. This is more especially true of parasitic fungi, saprophytes, being less specialised, are not so discriminating as to the nature of their food. This power on the part of parasitic fungi to discriminate in their choice of food, is called *chemotaxis*, or *chemtropism*, and a food that attracts the germ-tubes of a fungus is said to be positively chemotropic, whereas a substance that does not attract the germ-tubes is said to be negatively chemotactic to that fungus. From the above experiments it is assumed that when a spore alights on a given leaf, and germinates, if the cell-sap of the plant contains a substance suitable for the growth of the germ-tube ; that is, if the sap of the leaf is positively chemotactic, the germ-tube enters the leaf and forms a mycelium, whereas if the sap of the plant is negatively chemotactic, no infection takes place.

UREDINACEAE

All the species are obligate parasites, that is, they can only obtain their food from living plants. A vigorous septate mycelium is present, which wanders in the tissues of the host-plant. The spore-forms connected with reproduction, are as follows, given in the sequence of their appearance. Pycnidia (=spermogonia), producing very minute spore-like bodies, considered to be of no functional value at the present day. Aecidia, producing spores in chains, and enclosed in a peridium ; these spores give origin to the next stage in the cycle of development, uredospores, which are often produced throughout the period of vigorous growth of the host-plant. Uredospores are always 1-celled, and are capable of germination the moment they are mature. Germination consists in the protrusion of one or more germ-tubes, which enter a host-plant, and grow directly into ordinary mycelium. Teleutospores, the last spore-form in the cycle of development, may be 1-celled or many-celled, and are characterised by their remarkable product of germination, which consists of a promycelium bearing promycelium spores. As a rule teleutospores germinate during the spring following their production,

and the promycelium spores give origin to the pycnidia and aecidium forms, thus commencing the cycle over again. Mesospores and amphispores, as supplementary spore-forms, have been previously described.

KEY TO THE GENERA

A. *Teleutospores 1-celled.*

Teleutospores forming a small, powdery heap or sorus at maturity. Spores with one germ-pore at the apex. *Uromyces.*

Teleutospores and uredospores in the same sorus, emerging only through the stomata . . . . . *Hemileia.*

Teleutospore sorus forming a small, flattened, crust-like patch . . . . . *Melampsora.*

Teleutospores forming an erect, hair-like column. *Cronartium.*

Teleutospores in chains, enclosed in a peridium. *Endophyllum.*

Teleutospores colourless; parasitic on ferns. *Milesia.*

B. *Teleutospores 2-celled.*

Teleutospore sorus forming a small, powdery heap at maturity . . . . . *Puccinia.*

Teleutospores forming subgelatinous outgrowths; on junipers . . . . . *Gymnosporangium.*

C. *Teleutospores more than 1-septate, all the septa parallel.*

Teleutospores cylindrical, septa varying from 3—7. *Phragmidium.*

Teleutospores cylindrical, deeply notched at the septa, which vary from 8—15 in number. *Xenodochus.*

Teleutospores forming extended crusts on swollen stems of cowberry . . . . . *Calyptospora.*

Teleutospore sori flattish, crust-like; promycelium only bearing one promycelium spore at its tip. *Coleosporium.*

Teleutospore sorus enclosed in a peridium; growing on *Elymus* . . . . . *Rostrupia.*

D. *Teleutospores 3-septate, septa radiating from the centre of the spore.*

Teleutospores 3-septate . . . . . *Triphragmium.*

NOTES ON THE GENERA

UROMYCES

Aecidia, uredo- and teleutospore forms are often present. The aecidia or "cluster-cup" stage, as usual, appears

first. The enclosing wall or peridium is usually whitish, with a torn edge that curves outwards when mature. The aecidia are usually produced in groups or clusters on pale spots. The sori of uredospores and teleutospores usually appear under the form of small pustules, but in some instances when the teleutospore sori are produced on the stem, as on the broad-bean, the sori form long, blackish, crust-like patches. The teleutospores have a single germ-pore at the tip or apex.

HEMILEIA

The outstanding feature of this genus is the emergence of the sori of uredospores only through the stomata of the host-plant. In those species where the uredospores are crowded, the free, convex portion of each spore is warted or ornamented in some way, whereas those portions of the spores in contact with each other are smooth. When the sori are lax and the spores free from each other, they are warted all over. The teleutospores grow up in the centre of the uredospore clusters, and do not form independent sori.

An introduced genus.

MELAMPSORA

Teleutospores forming flat, crust-like sori on leaves. The spores are closely crowded side by side, and are usually prismatic or polygonal from lateral pressure. The most conspicuous species occur on the fallen leaves of poplars, alders and willows.

CRONARTIUM

(Our only species produces its aeciiospores on the bark of conifers (*Pinus* sp.).

The uredospores and teleutospores grow on the under-surface of living leaves of the black currant. The teleutospores are cemented together into a slender hair-like outgrowth, which is surrounded at the base by the uredospores. As a rule myriads of the hair-like collections of teleutospores crowd the surface of the infected leaf.

ENDOPHYLLUM

The only British species grows on the living leaves of houseleek, and allied plants. The peculiar teleutospores are globose and produced in chains, and are enclosed in a peridium. The whole structure resembles in appearance an aecidium, and was so considered until germinating

spores were seen to produce a promycelium, bearing promycelium spores.

MILESIA

The only known species is parasitic on the fronds of ferns. The sori are small and yellowish, and might be overlooked, except for their irregular disposition, for the sori of the fern.

PUCCINIA

The greatest variety of spore forms are met with in this genus. The aecidium or " cluster-cup " stage is often present. The peridium or wart enclosing the spores is short, not reaching much above the level of the surface of the leaf through which it bursts. When mature the edge of the peridium is usually torn into irregularly triangular teeth, which curl outwards, exposing the golden mass of spores. This stage appears in the spring, and is followed in order by the uredo-and teleutospore forms, which appear on leaves or stems as small, scattered or crowded, minute warts or pustules, which burst through the epidermis and expose the spores. The sori or pustules of uredospores are usually brown, and those of the teleutospores blackish, and the spores are two-celled.

GYMNOSPORANGIUM

The aecidial condition is characterised by having an elongated, cylindrical, or horn-like peridium. All are produced on plants belonging to the order Rosaceae; pear, hawthorn, mountain-ash, etc.

The teleutospores are parasitic on juniper branches, and cause swollen places, owing to the mycelium being perennial in the wood, and continuing to produce teleutospores year by year, over a gradually extending area of the host-plant. In old branches where the parasite has been present for some years, the swollen portions are usually more or less spindle-shaped, and may be a foot or more in length and three or four times the thickness of the normal part of the branch. During the spring these swollen portions become more or less thickly covered with dingy orange, subgelatinous masses of various forms, which ooze out through the bark. These masses consist of closely compacted teleutospores, which germinate *in situ*, the promycelium spores produced being dispersed by wind, infect the leaves of rosaceous plants, and give origin to the aecidium stage.

So far as is known, both spore stages are absolutely necessary for the continuance of the species included in

this genus. The teleutospore stage, being perennial in the tissues of the juniper, continues to produce teleutospores year by year, which are capable of infecting rosaceous plants and giving origin to the aecidium stage, but the teleutospores cannot directly infect a juniper, this can only result from infection by aecidiospores. The headquarters of this genus is in the United States, where the malformations caused to junipers are known as "Cedar apples."

PHRAGMIDIUM

All the species are parasitic on plants belonging to the order Rosaceae, roses, brambles, etc. The aecidia form small yellow pustules, and are not enclosed in a peridium, as in *Puccinia*, but the heap of spores, produced in chains, is surrounded by paraphyses. The uredospore sori resemble generally, those of the aecidia, and are also surrounded by paraphyses. The teleutospore sori usually form small black pustules on the under surface of leaves, and are often surrounded by a discoloured zone. Opinions differ much as to what is a species in this genus, counting the number of septa in a teleutospore, as followed by some, is of no value. Carefully conducted infection experiments can alone solve the problem.

XENODOCHUS

Teleutospore sori relatively large, convex, black. Spores composed of a single row of about 10—20 cells, deeply constructed at the septa, hence more or less resembling a string of beads.

The genus is closely allied to *Phragmidium*, differing mainly in the relatively greater number of cells composing the spore. The two genera are united by some authors.

CALYPTOSPORA

The white aecidia grow in two rows, one row on each side of the midrib, on the under surface of the leaves of conifers belonging to the genus *Abies*, silver fir, and other species. The aecidiospores are in chains, the component spores being connected by a narrow neck, resembling beads somewhat separated from each other on a string. The teleutospores form extended, swollen crusts on the branches of the cowberry. These crusts are whitish at first, then pink, and finally blackish-brown.

ROSTRUPIA

Parasitic on living leaves of *Elymus arenarius*, Lyme grass. Neither uredospore nor teleutospore sori are very

conspicuous, and require to be carefully searched for. The teleutospore sori are remarkable in being emclosed in a peridium composed of more or less parallel, coloured hyphae, a character that at once separates this from all allied genera.

TRIPHRAGMIUM

The peculiar structure of the teleutospores distinguish the present from every other British genus. They consist of three cells, but the three septa all radiate from the centre of the spore, thus each cell is triangular in outline, with the free or outside wall curved.

One species grows on meadowsweet, the other on dropwort.

UROMYCES, Link.

Pycnidia. Usually immersed, subglobose, with a slightly projecting conical neck.

Aecidia. Peridia immersed, globose and closed at first, then open and cup-shaped.

Uredospores. Sori pustulate or flattish.

Teleutospores. Sori forming small dark-coloured pustules; spores one-celled, with a single germ-pore at the tip, germinating by the protrusion of a promycelium, which bears promycelium spores.

Readily recognised by the 1-celled teleutospores with a single germ-pore at the tip.

According to Sydow there are 505 species of Uromyces known, their distribution is as follws :

	Species.	Endemic.
Europe	119	70
Asia	120	73
Africa	78	54
Australia...	31	22
America	249	221

VALERIANACEAE

Uromyces valerianae, Fuckel, Plowr., *Ured.*, p. 128.

Pycnidia. In minute groups, honey-colour.

Aecidia. Usually on the under surface of the leaves, rarely on the stem or petioles, seated on thickened, pale spots, crowded or in irregular rings, edge recurved, torn, spores angularly-globose, orange, finely and densely warted, 18—25 μ.

Uredospores. On both surfaces of the leaf, generally on yellowish spots, scattered or clustered, minute, brown and

powdery ; spores subglobose or broadly elliptical, sparingly echinulate, pale brown, 20—28 μ.

Teleutospores. Sori small, for a long time covered by the epidermis, brown : spores globose, subglobose or elliptical, smooth, brown, with a minute paler papilla at the tip, 20—28 × 16—21 μ, pedicel short, colourless.

Syn. *Aecidium valerianearum*, Duby.
Lecythea valerianae, Berk.

Sydow,—*Mon. Ured.*, p. 19, gives also the following synonomy under this species :
Uredo parnassiae, D.C.
Trichobasis parnassiae, Cooke.
Uromyces parnassiae, Plowr. *Mon., Ured.*, p. 128, in part.

On leaves, petioles and stem of *Valeriana dioica* and *V. officinalis*, etc. Europe generally, and Cape of Good Hope.

SCROPHULARIACEAE

Uromyces scrophulariae, Fuckel., Plowr., *Ured.* p. 139.

Aecidia. Generally on the under surface of the leaves, or on the stem, on yellowish spots, edge recurved, usually not torn ; spores angularly-globose, minutely warted, yellow, 17—30 μ.

Teleutospores. Sori on the under surface of leaves or on the stem, sometimes mixed with the aecidia, in rounded groups on the leaf, elongated on the petiole and stem, sometimes circinate, covered for a long time with the grey epidermis, then dusky brown and powdery ; spores variable in form, elliptical, ovate, or rarely subglobose, tip thickened, rounded, or sometimes rather pointed, base often narrowed, smooth, brown, 18—35 × 11—20 μ, pedicel about as long as the spore.

Syn. *Uromyces concomitans*, Berk. and Broome.
Puccinia scrophulariae, Lib.
Aecidium scrophulariae, D.C.

On leaves, petioles and stem of *Scrophularia aquatica*, *S. nodosa*, and other species. Europe generally.

The parasite forms yellowish or purplish spots, and causes much distortion of the host-plant.

PLUMBAGINACEAE

Uromyces limomii, Lév., Plow., *Ured.* p. 122.

Aecidia. Grouped on roundish, purplish spots on the leaves, or in elongated patches on the veins, shortly cy-

lindrical, whitish, edge torn ; spores angularly-globose or elliptical, yellow, minutely warted, 16—32 × 15—26 μ.

Uredospores. Sori scattered, generally roundish or elongated on the stem, for a long time covered by the epidermis, then naked, brown and powdery ; spores globose, ovate or oblong, pale brown, finely warted, 22—35 × 20—30 μ.

Teleutospores. Sori scattered or in circles, rounded or elongated on the stem, for a long time covered by the epidermis, then blackish and powdery ; spores subglobose, oblong or pear-shaped, tip rounded or narrowed, thickened, base usually narrowed, smooth, brown, 24—50 × 14—25 μ, pedicel long, stout, tinged brown, persistent.

Syn. *Puccinia limonii*, D.C.

On leaves and stem of *Statice limonium*, and other species. Plowright gives as a host-plant *Armeria vulgaris*, but the species on this host is *Uromyces armeriae*, Lév.

Europe generally, Siberia, N. Africa, and N. America.

Uromyces armeriae, Lév.

Pycnidia. Seated amongst the aecidia.

Aecidia. On both surfaces of the leaf, scattered or in small clusters, edge whitish, torn ; spores angularly-globose or broadly elliptical, minutely warted, yellow, 17—28 × 16—22 μ.

Uredospores. Most frequent on the stem, also on both sides of the leaves, rounded or elongated, covered for some time by the cracked epidermis, powdery, cinnamon ; spores subglobose, rarely elliptical, minutely warted, brownish, 24—32 × 21—28 μ.

Teleutospores. Like those of the uredo ; spores subglobose or ovate, tip thickened and rounded, base generally rounded, smooth, brown, 24—36 × 21—32 μ, pedicel about as long as the spore, deciduous.

Syn. *Caeoma armeriae*, Schlechtd.

On leaves and stem of *Armeria alpina*, *A. maritima*, and *A. vulgaris*. Europe generally.

Differs from *U. limonii* in the shorter and broader teleutospores, and in the shorter, colourless, deciduous pedicel. The uredospore has 2—3 germ-pores. This species has been confounded with *U. limonii*, Lév., by Plowright.

LEGUMINOSAE

Uromyces anthyllidis, Schroet., Plowr., *Ured.* p. 64.

Uredospores. Sori on both sides of the leaf, scattered,

often in a ring round a larger circular one, small, soon naked, cinnamon, powdery ; spores subglobose, sparingly echinulate, brown, 18—25 μ, epispore thick, 4—8 germ-pores.

Teleutospores. Sori similar in form to those of the uredo stage, but darker in colour ; spores subglobose or ovate, tip with a very minute papilla, warted, brown, 16—22 × 15—20 μ, pedicel short, colourless, deciduous.

Syn. *Uredo anthyllidis*, Grev.

On leaves of *Anthyllis vulneraria*. Europe generally.

Uromyces ervi, West., Plowr., *Ured.* p. 140.

Aecidia. Solitary or in small groups on the leaves, petioles and stem, edge slightly recurved, somewhat torn ; spores angularly-globose, yellowish, minutely warted, 16—25 × 14—18 μ.

Uredospores. Rarely produced, on leaves, petioles and stem, scattered, minute, oblong, surrounded by the ruptured epidermis, cinnamon ; spores ovate or elliptical, sparingly echinulate, brownish, 20—30 × 18—22 μ.

Teleutospores. Sori on both sides of the leaf, or often on the petioles or stem, scattered, oblong, minute, dusky brown ; spores subglobose, ovate or elliptical, tip generally rounded, much thickened, base rounded or narrowed, smooth, brown, 20—28 × 14—20 μ, pedicel persistent, tinged brown, longer than the spore.

On *Vicia hirsuta* (*Ervum hirsutum*). Plowright points out that this species, structurally, closely resembles *U. orobi*, *U. fabae*, and *U. pisi*, but will not grow on the hosts of these species, but only on *Vicia hirsuta*.

Uromyces fabae, De Bary., Plowr., *Ured.* p. 119.

Pycnidia. Intermixed with the aecidia.

Aecidia. Usually crowded on whitish or yellowish spots, edge whitish, recurved, torn ; spores angularly-globose, orange-yellow, minutely warted, 14—25 μ.

Uredospores. Sori on both surfaces of the leaf, scattered or arranged in circles, minute, powdery ; spores subglobose, elliptical or ovate, sparsely echinulate, pale brown, 20—30 × 18—26 μ, epispore 1.5—2.5 μ thick.

Teleutospores. Similar in form and arrangement to the uredo sori, dusky brown ; spores subglobose, ovate or elliptical, tip rounded or truncate, much thickened, smooth, brown, 25—40 × 18—27 μ, pedicel persistent, tinged yellow or brown, thick, longer than the spore.

Syn. *Uredo fabae*, Pers.

Uromyces appendiculatus, Unger.

On leaves and stems of *Faba vulgaris, Vicia cracca, V. sepium, V. sativa, Lathyrus pratensis, Pisum sativum,* and other species of leguminous plants. Europe, N. Africa, N. and S. America, Asia Minor, India, Japan and Australia.

The parasite has undoubtedly followed its host-plant, when of economic importance, to some of the countries indicated.

The uredospore has 3—4 germ-pores.

Uromyces orobi, Lév., Plowr., *Ured.*, p 121.

Pycnidia. On the under surface of the leaf, amongst the aecidia.

Aecidia. On yellowish spots on the under surface of the leaf, scattered or in circular or olbong groups, edges whitish, torn; spores angularly-globose or elliptical, minutely warted, orange, 14—27 μ.

Uredospores. Sori on both sides of the leaf, minute, crowded or scattered, soon powdery, brown; spores globose, subglobose or ovate, sparsely echinulate, pale brown, 15—28 × 16—25 μ.

Teleutospores. Sori like those of the uredospores in form, blackish; spores subglobose, ovate or elliptical, tip rounded or truncate, much thickened, smooth, brown, 25—40 × 18—28 μ.

Syn. *Aecidium orobi,* Pers.

On *Lathyrus macrorhizus* (*Orobus tuberosus*). Europe generally.

Uromyces appendiculatus, Link.

Pycnidia. Arranged in small, whitish spots.

Aecidia. Seated on yellowish or brownish spots on the under surface of the leaf, white, edge recurved and torn; spores subglobose or oblong, minutely warted, colourless, 18—36 × 15—24 μ.

Uredospores. Sori mostly on the under surface of the leaf, minute, scattered, or clustered here and there, soon naked and surrounded by the torn epidermis, cinnamon; spores subglobose or broadly elliptical, echinulate, pale brown, 18—34 × 15—22 μ, 2 germ-pores.

Teleutospores. Sori similar to those of the uredo stage, but dusky brown or black; spores subglobose, ovate or elliptical, tip rounded, usually with a rather large, pale papilla, smooth, or especially near the tip, with scattered, minute pale warts, chestnut-brown, 24—35 × 18—36 μ, pedicel almost colourless, about the length of the spore.

Syn. *Uromyces phaseoli*, Wint., Plowr., *Ured.*, p. 122.
Uromyces phaseolorum, De Bary.

On leaves of *Phaseolus vulgaris* ("Scarlet-runner"). Plowright does not appear to have met with this species, it is, however, certainly British, as it has been sent to Kew on several occasions for determination from various parts of the country.

Uromyces striatus, Schroet.

Pycnidia. Numerous, mixed with the aecidia.

Aecidia. Scattered over the under surface of the leaf, edge broadly revolute, torn, white; spores angularly-globose or elliptical, minutely warted, orange, 18—23 μ.

Uredospores. On both surfaces of the leaf, not forming spots, scattered, sometimes in groups and encroaching on each other, minute, powdery, cinnamon; spores subglobose or elliptical, sparingly echinulate, brownish, 15—22 μ diam., with 2—3 germ-pores, epispore 1.5—2 μ thick.

Teleutospores. Sori similar to those of the uredospore, dusky brown; spores globose, subglobose or ovate, tip with a minute papilla, more or less distinctly longitudinally striate, pale brown, 18—24 × 15—20 μ, pericel short, colourless, deciduous.

Aecidia on leaves of *Euphorbia cyparissias*; uredo- and teleutospores on *Medicago falcata, M. lupulina, M. falcata, Trifolium minor, T. arvensis, T. procumbens* (=*agrarium*).

Recorded from Jersey, Europe, N. and S. America, India.

Uromyces trifolii, Lév., Plowr., *Ured.*, p. 124 (in part).

Pycnidia and *aecidia* absent.

Uredospores. Sori on the under surface of the leaves or on the petioles, scattered, or here and there clustered, minute, larger when running into each other, soon naked and powdery, pale brown; spores globose, subglobose, ovate or elliptical, sparingly echinulate, pale brown, 18—26 × 17—24 μ, germ-pores, 5—7.

Teleutospores. Sori on the under surface of the leaf or on the petioles, scattered, or here and there clustered, minute, or larger when running into each other, at first covered by the epidermis, which soon splits, then powdery, dusky brown; spores subglobose, globose, elliptical or ovate, tip rounded, with a very small papilla, smooth, or sometimes very minutely warted, or with an indication of more or less parallel lines, brown, 18—30 × 16—25 μ, pedicel colourless, short, deciduous.

Syn. *Puccinia trifolii*, Hedw.
Puccinia fallens, Cooke.
Trichobasis fallens, Cooke.

On leaves and petioles of *Trifolium frangiferum*, *T. hybridum*, *T. medium*, *T. ochroleucum*, *T. pratense*. Europe, Asia Minor, Persia, N. America.

This species as understood by Plowright, embodied *Uromyces trifolii-repentis*, Liro. For distinctions between the two, see note under the last-named species, whose host-plant is *Trifolium repens*.

Uromyces trifolii-repentis, Liro.

Pycnidia. Arranged in minute, honey-coloured groups on the upper surface of the leaf.

Aecidia. On the under surface of the leaf in small, circular groups, in elongated groups on the nerves and petioles, shortly cylindrical, yellowish-white, edge slightly recurved, torn; spores angularly globose or elliptical, minutely warted, yellow, 17—21 × 14—18 μ.

Uredospores. Sori on the under surface of the leaf, or on the petioles, scattered or clustered, minute, often forming larger patches by running into each other, soon naked and powdery, pale brown; spores globose, subglobose or elliptical, pale brown, echinulate, 19—26 × 17—24 μ; germ-pores equatorial, 2—4, generally 2.

Teleutospores. Sori on the under surface of the leaf, or on the petioles, scattered or clustered, minute, larger when encroaching on each other, bounded by the split epidermis, powdery, dusky brown; spores globose, subglobose or elliptical, tip rounded, with quite a minute papilla, smooth, or sometimes very minutely warted, or with indistinct lines, brown, 18—30 × 16—25 μ, pedicel colourless, short, deciduous.

On leaves and petioles of *Trifolium repens*. Europe generally, Asia Minor, Persia, N. and S. America, Australia.

Distinguished from *Uromyces trifolii*, Lév., by the fewer germ-pores of the uredospore, and by the presence of aecidia. Confounded with the last-named species in this country.

EUPHORBIACEAE

Uromyces scutellatus, Lév., Plowr., *Ured.*, p. 134.

The mycelium permeates the entire host-plant.

Pycnidia. On the under surface of the leaf, scattered or numerous, sometimes absent.

Uredospores. Not in separate sori, but often mixed

with the teleutospores, broadly elliptical, minutely spinulose, yellowish brown, 20—35 × 15—25 μ, generally 4 germ-pores.

Teleutospores. Sori on the upper, rarely the under surface of the leaf, generally flat, dusky brown, bordered by the epidermis; spores variable in form and size, elliptical, globose or oblong, usually with a flattish papilla at the tip, brown, coarsely warted, warts often running into each other in rows, or elongated and smaller warted, 15—40 × 15—27 μ, pedicel slender, deciduous.

Syn. *Uromyces excavatus*, Cooke (not of D.C.).

Parasitic on leaves of *Euphorbia esula* and other species.

The mycelium of the teleutospore stage permeates the entire plant, causing much distortion and dwarfing.

GERANIACEAE

Uromyces geranii, Otth. and Wartm., Plowr., *Ured.*, p. 126.

Pycnidia. Scattered among the aecidia, orange.

Aecidia. On the under surface of the leaf, or on petioles, causing distortion, hemispherical and closed, then with a pore at the tip, finally with the edge slightly recurved, yellow; spores ovate, minutely warted, yellow, 20—30 × 15—24 μ.

Uredospores. Sori on the under surface of the leaf, on brownish spots, minute, scattered or in groups here and there, powdery, cinnamon; spores subglobose or elliptical, brown, sparingly echinulate, 20—30 × 17—24 μ, epispore rather thick, 1—2 germ-pores.

Teleutospores. Sori similar to those of the uredo stage in form and arrangement, dusky brown; spores subglobose or pear-shaped, with a long, pale papilla or wart at the tip, smooth, brown, 20—35 × 17—25 μ, pedicel short, colourless, deciduous.

Syn. *Trichobasis geranii*, Berk.

On *Geranium sylvaticum*, *G. pratense*, *G. molle*, *G. dissectum*, *G. sanguineum*, *G. rotundifolium*.

The aecidiospores often distort the stem of the host-plant.

ROSACEAE

Uromyces alchemillae, Lév., Plowr., *Ured.*, p. 137.

Uredospores. Sori on the under surface of the leaf, often covering the entire surface, often arranged radially, powdery, yellow or orange; spores globose or elliptical, minutely echinulate, yellow, 15—25 × 14—21 μ.

Teleutospores. Sori on the under surface of the leaf, arranged as in the uredo form, minute, brown; spores subglobose or elliptical, tip not thickened, rather coarsely warted, brown, 26—40 × 20—35 μ, pedicel colourless, deciduous.

Syn. *Uredo alchemillae,* Pers.
Uredo intrusa, Grev.
Uromyces intrusus, Lév.

On *Alchemilla vulgaris.*

The mycelium of this species is perennial in the host-plant, and causes distortion and dwarfing of the leaves and elongation of the stem. The above remarks apply to the action of the fungus produced from the perennial mycelium present in the host-plant. Leaves that are infected by the uredospores of the first generation, do not become distorted.

RANUNCULACEAE

Uromyces ficariae, Lév., Plowr., *Ured.,* p. 140.

Teleutospores. Sori on both surfaces of the leaf, minute, rounded, in round or elongated patches, often crowded and running into each other, forming large pustules, soon naked and powdery, dusky brown; spores subglobose or ovate, pale brown, smooth usually with a minute pale wart at the tip, 22—44 × 16—26 μ, pedicel short, colourless, deciduous. Uredospores are sometimes found mixed with the teleutospores; spores subglobose or elliptical, minutely echinulate, 18—30 × 17—25 μ, 3 germ-pores.

Syn. *Uredo ficariae,* Schum.

On *Ranunculus ficaria.* Europe generally.

The fungus often causes distortion of the stem of the host-plant.

Uromyces aconiti-lycoctoni, Wint.

Aecidia. On yellow spots on the under surface of the leaves, or on the petioles, forming groups, yellow, edge of cup recurved; spores minutely warted, 20—35 × 18—30 μ.

Teleutospores. On yellowish spots on the upper surface of the leaf, sori usually in groups; spores subglobose or elliptical, tip very slightly thickened, smooth, brown, 20—40 × 20—30 μ, pedicel short, deciduous.

Syn. *Uromyces aconiti,* Fuckel.

On *Aconitum lycoctonum,* and other species of Aconite. Sometimes occurs on cultivated plants in this country. Europe generally, United States.

No distinct uredospore sori known, but a few uredospores rarely occur with the teleutospores.

CARYOPHYLLACEAE

Uromyces behenis, Unger, Plowr., *Ured.*, p. 138.

Aecidia. Generally on the under surface of the leaf, on spots of various sizes, clustered or sometimes solitary, tinged yellow, edge recurved and torn; spores angularly globose, minutely warted, yellow, 15—21 μ.

Teleutospores. Sori generally on the under surface of the leaves, or on the stem, often mixed with the aecidia, scattered or in groups, covered for a long time by the greyish epidermis, minute, almost black; spores subglobose or ovate, tip rounded and much thickened, smooth, pale, brown, 25—40 × 17 — 27 μ, pedicel persistent, thick, twice as long as the spore.

Syn. *Aecidium behenis*, D.C.

On *Silene inflata* and *S. maritima*. Europe generally. The host-plant is often much distorted.

Uromyces sparsus, Lév., Plowr., *Ured.*, p. 136.

Uredospores. Sori on both sides of the leaves, or on the stem, scattered on pale spots, convex, for a long time covered by the epidermis, which cracks and shows the pale cinnamon, powdery mass of spores; spores globose or oblong, minutely echinulate, brownish, 18—25 × 15—22 μ.

Teleutospores. Sori resembling those of the uredo form in shape and size, but darker; spores subglobose, ovate or oblong, frequently narrowed below, tip rounded, slightly thickened and darker, smooth, brown, 22—40 × 14—24 μ, pedicel persistent, thick, long, apex brownish.

Syn. *Uredo sparsa*, Kze. and Schwam.

On *Spergularia rubra*. Germany, France, Denmark.

CHENOPODIACEAE

Uromyces betae, Lév., Plowr., *Ured.*, p. 127.

Pycnidia. Honey-colour, arranged in minute clusters.

Aecidia. Sori occur on both surfaces of the leaves, on yellowish rounded or elongated spots, yellowish, edge recurved and torn; spores angularly globose, minutely warted tinged yellow, 15—25 μ.

Uredospores. Sori scattered or arranged in circles, on both surfaces of the leaves, surrounded by the torn epidermis, powdery, cinnamon; spores subglobose, elliptical or oblong, sparingly echinulate, pale yellowish-brown, 21—32 × 16—26 μ.

Teleutospores. Sori resembling those of the uredo stage, but more compact, dusky brown; spores subglobose or ovate, tip rounded, and with a minute pale wart, smooth, pale brown, 22—35 × 18—25 μ, pedicel short, colourless, deciduous.

Syn. *Uredo betae*, Pers.
Trichobasis betae, Lév.

On *Beta maritima*, also on cultivated mangolds and beet (*Beta vulgaris*). Europe generally, California, S. Africa, and Australia.

I have observed that the uredospores are usually much more distinctly spinulose on wild beet, than on mangold or cultivated beet.

Uromyces salicorniae, De Bary, Plowr., *Ured.*, p. 129
Aecidia. Principally appearing on the cotyledons, hemispherical, then opening, edge erect, torn, whitish; spores angularly globose, minutely warted, tinged yellow, 17—35 μ.

Uredospores. Sori scattered or clustered, minute, for a long time covered by the epidermis; spores ovate, elliptical or pear-shaped, minutely echinulate, yellowish-brown, 20—35 × 18—25 μ.

Teleutospores. Sori resembling those of the uredo stage, in size and disposition, dusky brown; spores subglobose or elliptical, tip rounded, and often slightly thickened, base generally rounded, smooth, brown, 24—36 × 15—28 μ pedicel long, thick, persistent.

On *Salicornia herbacea.* Germany, France.

POLYGONACEAE

Uromyces polygoni, Fuckel; Plowr., *Ured.*, p. 123.
Pycnidia. Honey-coloured, in small groups.

Aecidia. Sori on the upper surface of the leaves, or less frequently on the stem, on reddish-violet spots, in irregular clusters or in circles, whitish, edge recurved and torn; spores angularly globose or elliptical, pale yellow, finely warted, 15—23 × 14—18 μ.

Uredospores. Sori on both sides of the leaves, and on the stem, minute, scattered or clustered, rarely forming rings, soon naked, powdery, cinnamon; spores subglobose or elliptical, minutely warted, pale brown, 18—26 × 15—24 μ, wall thickish, 3—4 germ-pores.

Teleutospores. Sori on both sides of the leaves and on the stem, in rounded clusters on the leaves, and elongated

clusters on the stem, dusky brown ; spores subglobose or ovate, tip rounded and thickened, smooth, chestnut-brown 22—38 × 14—22 μ, pedicel long, stout, tinged yellowish or brown, persistent.

Syn. *Puccinia vaginalium*, Link.
Aecidium aviculare, Kze.
Trichobasis polygonorum, Berk.
Uromyces polygonorum, D.C.

On *Polygonum aviculare*, also on other species of *Polygonum* in other countries. Europe generally, Greece, Egypt, Madeira, Asia Minor, Persia, Japan, N. America, S. Africa, and Australia.

This species is also parasitic on *Rumex acetosella* on the Continent, and may be found on that host in this country. It often distorts the stem of the host-plant.

Uromyces rumicis, Wint., Plowr., *Ured.*, p. 135.

Uredospores. Sori on both sides of the leaf, scattered spots of various sizes, minute, circular, soon naked and powdery, cinnamon ; spores subglobose or elliptical, echinulate, pale brown, 20—28 × 18—30 μ, 2—3 germ-pores.

Teleutospores. Similar to those of the uredo form, but darker in colour ; spores subglobose, ovate, elliptical or pear-shaped, brown, with a pale round papilla or wart at the tip, smooth or almost so, 24—35 × 15—25 μ, pedicel slender, colourless, deciduous.

Syn. *Uredo rumicis*, Schum.
Uredo bifrons, D.C.

On *Rumex conglomeratus*, *R. obtusifolius*, *R. crispus*, *R. hydrolapathum*, *R. acetosa*, *R. maritimus*. Europe generally ; Algeria, United States, Chili, S. Africa.

LILIACEAE

Uromyces gageae, G. Beck.

Teleutospores. Sori occurring on both sides of the leaves, no distinct spots, scattered, circular or elliptical, covered with the grey epidermis, which splits lengthwise, becoming naked and powdery, dusky brown ; spores subglobose, elliptical or pear-shaped, tip not thickened, but with a pale wart, smooth, brown, 25—40 × 17—28 μ, epispore rather thick, pedicel long, slender, deciduous.

Syn. *Uromyces ornithogali*, Plowr., *Ured.*, p. 142.

On *Gagea lutea*. Europe generally.

This species was confounded with *Uromyces ornithogali*, Lév. an allied species, not yet recorded as occurring in Britain

Uromyces scillarum, Wint., Plowr., *Ured.*, p. 141.

Teleutospores. Sori on both surfaces of the leaf, minute, rounded or oblong, usually on pale spots, more or less crowded, often in rings, for a long time covered by the epidermis, then powdery, dusky brown; spores globose, ovate or oblong, tip generally rounded, not thickened, smooth, or with a few faint lines running from tip to base, these sometimes run into each other, brown, epispore thin, 18—32 × 14—22 μ, pedicel about as long as the spore, slender, generally falling early.

Syn. *Uredo scillarum*, Grev.
Puccinia scillarum, Baxt.
Trichobasis scillarum, Berk.
Uromyces concentricus, Lév.

On *Scilla bifolia* and *S. nutans*.

Distinguished by the very thin wall of the spore, 1—1.5 μ, and by the fine, sometimes anastomosing lines, running the length of the spore.

JUNCACEAE

Uromyces junci, Tul., Plowr., *Ured.*, p. 132.

Pycnidia. Generally on the upper surface of the leaves.

Aecidia. On the under surface of the leaves, on purplish spots bounded by a yellowish margin, or altogether yellowish, more or less crowded, sometimes in circles, yellowish-white, edge recurved and torn; spores angularly globose, minutely warted, orange, 15—23 μ.

Uredospores. Sori on brown or yellowish long spots, minute, scattered, rounded or elongated, bordered by the torn epidermis, brown, powdery; spores subglobose or elliptical, finely warted, yellowish-brown, 17—28 × 16—22 μ, 2 equatorial germ-pores.

Teleutospores. Sori scattered, or in round or oblong groups, sometimes growing into each other and forming larger sori, bounded by the torn epidermis, blackish; spores usually elliptical or pear-shaped, tip rounded, or sometimes slightly narrowed, very much thickened, base narrowed, smooth, deep brown, 20—42 × 12—20 μ, pedicel long, tinged brown, persistent.

Syn. *Aecidium zonale*, Desm.

Pycnidia and Aecidia on *Inula dysenterica*. Uredospores and teleutospores on *Juncus obtusiflorus*, *J. acutus*, *J. bufonius*, *J. lamprocarpus*. Europe generally; Algeria, N. America, Chili, Brazil, Paraguay.

CYPERACEAE

Uromyces scirpi, Burr.

Pycnidia. Generally on the upper surface of the leaf.

Aecidia. On the under surface of the leaves, or on the petioles, in clusters, edge revolute and split; spores angularly globose, minutely warted, yellowish, 16—24 × 14—20 μ.

Uredospores. Sori scattered or in lines, on the under surface of the leaves, minute, rounded or oblong, powdery, cinnamon; spores subglobose, ovate or oblong, minutely echinulate, yellowish-brown, 22—35 × 16—25 μ, 3 equatorial germ-pores.

Teleutospores. Sori on both surfaces of the leaves, on indeterminate discoloured spots, scattered or arranged in lines, for a long time covered by the epidermis, dusky brown; spores ovate, oblong or pear-shaped, tip generally narrowed, thickened, base narrowed, smooth, pale brown, 26—45 × 15—24 μ, pedicel tinged brown.

Syn. *Uromyces maritima,* Plowr.

Aecidium glaucis, Plowr., *Ured.,* p. 268.

Pycnidia and aecidia on *Glaux maritima, Hippuris vulgaris, Dauca carota, Pastinaca sativa, Sium latifolium.*

Uredo- and teleutospore stages on *Scirpus maritimus.* Europe generally; N. America.

Plowright observed that the teleutospores found on *Scirpus maritimus* produced aecidia on *Glaux maritima* and named the teleutospore form *Uromyces maritima* (*Gard. Chron.,* 1890, pp. 682 and 746), not being aware that it had been named *Uromyces scirpi* by Burrill, in the United States, in 1885.

GRAMINACEAE

Uromyces dactylidis, Otth.; Plowr., *Ured.,* p. 130.

Pycnidia. On the upper surface of the leaves, honey-colour, also scattered amongst the aecidia on the under surface of the leaves.

Aecidia. On the under surface of the leaves, and on the petioles, on yellowish spots, yellowish, edge recurved and slightly torn; spores subglobose, minutely warted, pale yellow, 15—25 μ.

Uredospores. Sori on both surfaces of the leaf, scattered or arranged in lines, for a long time covered by the epidermis, then powdery and yellowish-brown; spores globose, rarely ovate, minutely echinulate, yellow or yellowish-brown, 18—32 × 18—25 μ, 7—9 germ-pores, no paraphyses.

Teleutospores. Sori generally on the under surface of the leaves, minute, roundish or elongated, scattered or in irregular lines, sometimes growing into each other and forming large sori, for a long time covered by the epidermis, compact, blackish; spores generally ovate, sometimes irregularly rounded, or oblong, apex rounded, rarely truncate, not at all or only slightly thickened, darker, yellowish-brown, 18—30 × 14—20 μ, pedicel tinged brown, paraphyses tufted, brown.

Syn. *Aecidium ranunculacearum*, D.C.

Pycnidia and aecidia on *Ranunculus bulbosus, R. acris.* Uredospores and teleutospores on *Dactylis glomerata.* Europe generally.

Uromyces poae, Rabenh.; Plowr., *Ured.*, p 131.

Pycnidia. On the upper surface of the leaf, also mixed with aecidia on the under surface of the leaf, honey-colour.

Aecidia. On the under surface of the leaves, and on the petioles in round clusters, on yellowish spots, or in elongated lines on the petioles, yellowish, edge recurved and torn; spores subglobose, minutely warted, yellowish, 17—25 × 12—20 μ.

Uredospores. Sori on both surfaces of the leaf, scattered or in lines, elliptical or oblong, covered by the epidermis, then powdery, yellowish-brown; spores subglobose, ovate or elliptical, minutely echinulate, yellowish, 14—26 × 14—20 μ, 4—9 germ-pores, paraphyses sometimes present.

Teleutospores. Sori generally on the under surface of the leaves, scattered or in rows, minute, or running into each other and forming large sori, covered by the epidermis, compact, blackish; spores ovate, elliptical or pear-shaped, tip rounced or truncate, not at all, or very slightly thickened, smooth, yellowish-brown, tip darker, 17—28 × 14—20 μ, pedicel tinged brown, paraphyses tufted, brown.

Syn. *Aecidium crassum*, var. *ficariae*, Pers.
Aecidium ranunculacearum, D.C.
Aecidium confertum, Grev.

Pycnidia and aecidia on *Ranunculus auricomus, R. bulbosus, R. repens, R. ficaria.*

Uredo- and teleutospores on *Poa annua, P. bulbosa, P. compressa, P. pratensis, P. trivialis, Agrostis alba.* Europe generally; Asia Minor.

Morphologically close to *U. dactylidis*, distinguished by the smaller uredospores. Biologically distinct.

European species of Uromyces parasitic on host-plants that are natives of Britain, but have not been recorded as occurring in this country.

COMPOSITAE

Uromyces solidaginis, Niessl.

Teleutospores. Sori on yellowish spots on under surface of leaf, or on petioles and stems; spores, elliptical or oblong, smooth, tip rounded and much thickened, 21—38 × 14—21 μ, pedicel persistent.

On *Solidago virgaurea.*

CAMPANULACEAE

Uromyces phyteumatum, Unger.

Teleutospores. Sori on under surface of leaf, minute, but generally crowded over surface of leaf; spores subglobose or elliptical, tip rounded and slightly thickened, smooth, 21—35 × 16—24 μ, pedicel long, slender, colourless, deciduous.

On *Phyteuma orbiculare* and *P. spicatum.*

SCROPHULARIACEAE

Uromyces thapsi, Bubak.

Aecidia. Generally on under surface of leaf, on yellowish or purplish spots, yellow, edge erect and torn; spores warted, 18—25 × 14—21 μ.

Teleutospores. Sori on under surface, mixed with aecidia or scattered, blackish; spores ovate or elliptical, smooth, brown, tip rounded, slightly thickened, 18—35 × 11—18 μ, pedicel persistent.

On *Verbascum lychnitis, V. nigrum, V. thapsus* and *V. thapsiforme.*

LEGUMINOSAE

Uromyces astragali, Sacc.

Pycnidia and *aecidia* present.

Uredospores. Sori on both sides of leaf, minute, often covering the leaf; spores echinulate, 15—24 × 14—22 μ, 3—4 germ-pores.

Teleutospores. 14—24 × 14—21 μ.

Aecidia on *Euphorbia cyparissias*; uredo- and teleutospores on *Astragalus, Oxytropis, Onobrychis.*

Uromyces genistae-tinctoriae, Wint.

Uredospores. Sori seated on pale spots on the under surface of the leaf; spores very minutely echinulate, 20—28 × 18—24 μ, 3—6 germ-pores.

Teleutospores. Subglobose or ovate, brown, with a very minute pale papilla, either all warted, or upper part warted and more or less striate below, or altogether longitudinally striate, 16—28 × 14—20 μ, pedicel short, deciduous.

On leaves of *Genista anglica, G. tinctoria, Sarothamnus scoparius.*

Uromyces loti, Blytt.

Pycnidia and *aecidia* present.

Uredospores. Sori on both sides, minute; spores sparingly echinulate, 17—25 × 16—23 μ, epispore thick, 2—3 germ-pores.

Teleutospores. Spores globose or ovate, brown, with a very minute papilla, very minutely warted, warts often in rows, 17—25 × 14—21 μ, pedicel short, deciduous.

Aecidia on *Euphorbia cyparissias*; uredo- and teleutospores on *Lotus corniculatus.*

Uromyces onobrychidis, Lév.

Uredospores. Sori on both sides, echinulate; spores 18—32 × 15—22 μ.

Teleutospores. Spores subglobose or elliptical, brown, with a minute papilla at the tip, very minutely warted, 20—24 × 17—21 μ, pedicel short, deciduous.

On *Onobrychis sativa.*

Uromyces ononidis, Pass.

Uredospores. Sori minute, on both sides; spores sparingly echinulate, 18—26 × 17—22 μ, 3—4 germ-pores.

Teleutospores. Spores globose or ovate, with a very minute papilla at the tip, warted, dark brown, 18—26 × 15—24 μ, pedicel short, deciduous.

On *Ononis spinosa.*

Uromyces pisi, Wint.

Pycnidia on the under surface intermixed with the numerous aecidia; spores orange, warted, 18—23 μ.

Uredospores. Spores minutely warted, 21—25 μ, wall thick, 2—3 germ-pores.

Teleutospores. Spores globose or elliptical, with a pale papilla at the tip, brown, densely and minutely warted, 20—28 × 14—22 μ, pedicel short, colourless, deciduous.

Aecidia on *Euphorbia cyparissia* and *E. esula*; uredo and teleutospores on *Pisum sativum, Lathyrus silvestris, L. angustifolia, L. pratensis.* Has been reported to occur in Jersey

Uromyces minor, Schroet.

Aecidia. On yellowish spots on the under surface; spores densely warted, 14—20 μ.

Uredospores. Sori generally on the upper surface.

Teleutospores. Spores globose or ovate, with a very minute papilla, brown, very minutely warted, 15—25 × 14—18 μ, pedicel short, deciduous.

On *Trifolium pratense.*

Uromyces heimerlianus, P. Magn.

Uredospores. Sori on under surface, minute; spores minutely warted, 18—24 μ, 3—5 germ-pores.

Teleutospores. Spores globose or ovate, brown, minutely and densely warted, 20—30 × 18—25 μ, pedicel short, deciduous.

On *Vicia hirsuta.*

Uromyces vicia-craccae, Const.

Uredospores. Sori minute, on the under surface.

On *Vicia cracca.*

Uromyces briardi, Har.

Uredospores. Sori scattered, or here and there crowded, generally on the upper surface; spores echinulate, 19—23 × 18—21 μ.

Teleutospores. Spores subglobose or ovate, tip not thickened nor papillate, brown, with large, pale, more or less conical warts, 22—32 × 20—25 μ, pedicel slender, deciduous.

On *Vicia sativa.*

EUPHORBIACEAE

Uromyces tuberculatus, Fuckel.

Mycelium permeates the entire plant.

Pycnidia and *aecidia* scattered over the entire under surface of the leaves; spores 17—25 × 14—20 μ.

Uredospores. Sori scattered on upper surface; spores aculeolate, 20—25 μ, 5—7 germ-pores.

Teleutospores. Sori on both surfaces and stem, blackish; spores globose or elliptical, papilla broad, pale, with scattered conical, blunt warts, brown, 20—30 × 18—24 μ, pedicel deciduous.

On *Euphorbia exigua.*

GERANIACEAE

Uromyces truncatulus, Trotter.

Uredospores. Sori on the under surface; spores globose or elliptical, minutely warted, 24—35 × 20—28 μ, epispore thick.

Teleutospores. Spores subglobose or elliptical, tip truncate or with a minute papilla, base rounded, smooth, bright brown, 28—45 × 24—32 μ, pedicel rather long.
On *Geranium striatum.*

ROSACEAE

Uromyces melosporus, Syd.
Teleutospores. Sori on under surface, covering all or greater part of leaf; spores globose or elliptical, brown, coarsely warted, tip not thickened, 20—38 × 20—28 μ; uredospores are mixed, spores minutely echinulate, 20—26 × 18—21 μ.
On *Alchemilla alpina.*

CARYOPHYLLACEAE

Uromyces caryophyllinus, Wint.
Uredospores. Sori on both sides and on stem, on pale spots; spores echinulate, 20—30 × 18—25 μ, wall thick, 4—5 germ-pores.
Teleutospores. Sori often oblong; spores globose or elliptical, with a minute pale wart at the tip, minutely but densely punctate, chestnut-brown, 20—31 × 18—24 μ, pedicel hyaline, short.
On *Dianthus armeria, D. caryophyllus.*

CHENOPODIACEAE

Uromyces salsolae, Reich.
Pycnidia and *aecidia* mixed on the leaves.
Uredospores. Sori on leaves and stem; spores minutely echinulate, 22—27 × 15—20 μ, 6—9 germ-pores.
Teleutospores. Sori large, on leaves and stem; spores globose or elliptical, tip generally rounded, thickened, smooth, brown, 22—35 × 18—28 μ, pedicel thick, persistent, long.
On *Salsola kali.*

Uromyces chenopodii, Schroet.
Aecidia. Cylindrical, whitish, edge deeply cut.
Uredospores. Spores subglobose or elliptical, echinulate, 18—25 × 16—21 μ.
Teleutospores. Sori often large; spores variable, subglobose, ovate or club-shaped, tip rounded or narrowed, more or less thickened, smooth, brown, 24—26 × 14—25 μ, pedicel long, tinged yellow, persistent.
On *Sueda fruticosa* and *S. maritima.*

POLYGONACEAE

Uromyces acetosae, Schroet.

Pycnidia and *aecidia* on both sides of leaves, and on stem.

Uredospores. Sori on both sides, on reddish-purple spots; spores minutely warted, 18—25 × 17—22 μ, 3 germ-pores.

Teleutospores. Spores globose or elliptical, tip not thickened, rarely with a minute pale wart, base rounded, with minute warts arranged in lines, 21—26 × 20—24 μ.

On *Rumex acetosa* and *R. acetosella.*

IRIDACEAE

Uromyces croci, Pass.

Teleutospores. Sori on both surfaces; spores subglobose or elliptical, tip rounded, not appreciably thickened, very minutely warted, brown, 24—32 × 21—28 μ, epispore thick, pedicel colourless, deciduous.

On *Crocus biflorus* and *C. vernus.*

LILIACEAE

Uromyces ambiguus, Lév.

Uredospores. Sori on both surfaces, permanently covered by the epidermis; spores globose or elliptical, echinulate, very pale, 20—28 × 17—22 μ, 6—7 germ-pores.

Teleutospores. Sori on leaves and stem, covered by the epidermis; spores subglobose, ovate or pear-shaped, tip rounded, not thickened, smooth, brown, 20—35 × 17—24 μ, pedicel slender, deciduous.

On *Allium schoenoprasum* and *A. sphaerocephalum.*

Uromyces ornithogali, Lév.

Teleutospores. Sori scattered, minute; spores subglobose or elliptical, tip not thickened, but with a rather long pale wart, brown, 25—48 × 20—32 μ.

On *Muscari racemosum.*

GRAMINACEAE

Uromyces festucae, Syd.

Pycnidia and *aecidia* present.

Uredospores. Sori on the upper surface on yellow spots; spores globose or elliptical, echinulate, yellow, 20—32 × 18—24 μ, epispore thick, 6—8 germ-pores, paraphyses absent.

Teleutospores. Sori on upper surface, often in circles, black; spores ovate or pear-shaped, rarely oblong, tip

rounded, slightly or not at all thickened, smooth, pale brown, tip darker, 20—33 × 17—22 μ, pedicel tinged brown.

Aecidia on *Ranunculus bulbosus*.

Uredo-and teleutospores on *Festuca ovina*, and *F. rubra*.

Uromyces ranunculi-festucae, Jaap.

Pycnidia and *aecidia* present.

Uredospores. Sori on the upper surface on yellow spots ; spores echinulate, yellow, 6—8 germ-pores.

Teleutospores. Sori on yellow spots, rarely on dark spots, black ; spores ovate, pear-shaped or oblong, tip rounded, truncate or slightly narrowed, smooth, pale brown, tip darker, 20—40 × 15—22 μ, pedicel tinged brown.

Pycnidia and aecidia on *Ranunculus bulbosus*.

Uredo-and teleutospores on *Festuca ovina*.

MELAMPSORA, Castagne

Pycnidia. Forming minute, circular, covered patches.

Aecidia. Spores produced in chains, not enclosed in a peridium.

Uredospores. Spores enclosed in a more or less well-developed peridium.

Teleutospores. Spores 1-celled, wedge-shaped, crowded into a compact, crust-like patch.

The teleutospores on germination give origin to a promycelium bearing secondary spores, as in *Puccinia*.

The present genus has been divided in different ways by various authors, but the life-history of many so-called species is as yet unknown.

Melampsora repentis, Plowr.

Pycnidia. On yellowish spots on the leaves.

Aecidia. Patches irregular, growing into each other, yellow ; spores subglobose or ovate, very minutely warted, yellow, 17—28 × 12—20 μ.

Uredospores. Sori small ; spores subglobose, minutely spinulose, 12—15 μ, diam., orange ; paraphyses colourless, tip subglobose.

Teleutospores. Sori yellow, then brown, finally blackish ; spores cylindrical, crowded and polygonal in section, brown, 50—60 × 10—12 μ.

Syn. *Caeoma orchidis*, Alb. and Schw. ; Plowr., *Ured.*, p. 261.

Pycnidia and aecidia on *Orchis maculata*, *O. latifolia* and *Listera ovata*.

Uredospores and Teleutospores on *Salix repens*.

Melampsora lini, D.C. ; Plowr., *Ured.*, p. 237.

Uredospores. Sori small, scattered, circular, soon powdery, on the leaves, sepals, etc. ; spores subglobose, echinulate, orange-yellow, 15—25 × 13—16 μ.

Teleutospores. Sori more or less circular, brown then blackish ; spores formed under the cuticle, somewhat cylindrical, polygonal in section from mutual pressure, brownish, 45 × 20 μ.

Syn. *Uredo lini*, D.C.

Lecythea lini, Berk.

On flax—*Linum usitatissimum*, and on purging flax—*Linum catharticum*.

This fungus often proves very destructive to cultivated flax.

Melampsora pinitorqua, Rostrup.

Pycnidia. Forming minute, yellowish spots on the leaves and bark.

Aecidia. Appear on the leaves and young shoots, forming orange patches ; spores subglobose, pale reddish-yellow, minutely warted, 15—20 μ diam.

Uredospores. Sori orange-yellow, mostly on the under surface of the leaf, also on the young shoots, soon powdery ; spores subglobose, elliptic or ovoid, echinulate, orange, 40—50 × 16—24 μ ; paraphyses with the tip globose.

Teleutospores. Sori on the under surface of the leaves, brown then blackish, flattened ; spores elongated, tip blunt, narrowed downwards, brownish, smooth, 40—50 × 11—14 μ.

The aecidia grow on the leaves and young shoots of *Pinus silvestris* and *P. montana*.

The teleutospores occur on poplar leaves—*Populus tremula*, *P. alba*, and *P. canescens*. The latter is by some considered as a hybrid between *P. tremula* and *P. alba*.

The synonymy is too intricate to be attempted here.

CRONARTIUM, Fries

Aecidia. Produced on conifers, elongated ; spores produced in chains, orange.

Uredospores. Sori within a special covering or peridium ; spores produced singly.

Teleutospores. Spores 1-celled, compacted into a long bristle-like projection, which springs from the middle of the uredospore sorus. The spores germinate on the host-plant,

producing a promycelium, bearing minute secondary, or promycelial spores.

The bundles of teleutospores resemble stout, yellowish-brown hairs projecting from the infected leaves.

Cronartium ribicolum, Deitr.

Aecidia. Large, bursting through the bark in great numbers, eventually rupturing and liberating a powdery mass of orange spores. One part of the spore wall is smooth, the remainder warted.

Uredospores. Elliptical or ovoid, orange, aculeate, 19—35 × 14—22 μ.

Teleutospores. Forming a yellowish-brown column springing from the centre of the sorus of uredospores; spores 1-celled, elongated, germinating *in situ.*

Syn. *Peridermium strobi,* Klebahn.

The aecidia occur on the trunk and branches of *Pinus strobus,* the Weymouth pine; *P. cembro* and *P. lambertiana.*

The uredospores and teleutospores on the under surface of living leaves of black currant—*Ribes nigrum.*

Often proving very injurious to conifers.

Cronartium flaccidum, Winter.

Uredospores. Variable in form, pale orange, aculeolate, elliptical or ovate, 20—30 × 13—20 μ.

Teleutospores. Forming cylindrical or hair-like sori, often curved, pale brown; spores oblong or cylindrical, 1-celled, ends blunt, brown, 8—12 μ broad.

Syn. *Cronartium paeoniae,* Cast.

Aecidial stage unknown.

The teleutospore and uredospore stages grow on living leaves of various species of cultivated paeonies, as *Paeonia officinalis,* etc.

ENDOPHYLLUM, Lév.

Teleutospores. Forming a sorus enclosed in a peridium or wall composed of sterile cells; spores produced in basipetal chains; germinating by the formation of promycelium, which bears secondary or promycelial spores.

Accidia and uredospores unknown. The teleutospores resemble in general appearance, an aecidium, being surrounded by a wall, or peridium, and the spores are produced in basipetal spores as in Aecidium, but the germination resembles that of the teleutospores in other genera.

Endophyllum sempervivi, Lév.

Pyncidia. Globose then conical, honey-colour.

Teleutospores. Scattered, immersed in the substance of the leaf, at first closed, then opening by a small perforation, finally broadly open and cup-shaped, edge whitish; spores angularly globose, minutely warted, orange, 20—30 μ diam.

Syn. *Uredo sempervivi*, Alb. and Schw.

On living leaves of houseleek—*Sempervivum tectorum*, and allied cultivated species.

During the first year of infection, the leaves are not much altered in appearance, but the mycelium is perennial, and during succeeding years the infected leaves become much longer than normal ones, and stand more or less erect.

Endophyllum euphorbiae-silvaticae, Lév.

Pycnidia. Mostly on the upper surface of the leaves, honey-colour.

Teleutospores. Sori immersed in the substance of the leaf, mostly on the under surface, circular, edge of peridium thick, erect; spores subglobose, minutely warted, orange, 16—26 × 12—18 μ.

Syn. *Endophyllum euphorbiae*, Plowr., *Ured.*, p. 228.
Aecidium euphorbiae, Pers.

On *Euphorbia amygdaloides.*

The plants are altered in appearance, the leaves being stunted and covered with the fungus. Such infected plants rarely bloom.

Plowright states that he did not succeed in infecting old plants, not even on the youngest leaves, but that seedlings were readily infected, the mycelium passing into the stem, and showing the disease in after years. The mycelium is perennial in the host-plant.

MILESIA, White

Teleutospores only known. Spores 1-celled, enclosed in a peridium which is sunk in the substance of the matrix, the 1-celled spores eventually escaping through a small aperture at the apex of the peridium.

The one known species, parasitic on ferns, is unfortunately rare, but very little is known respecting its life-history.

Milesia polypodii, White.

Teleutospores. Sori yellow, scattered or encroaching on each other, enclosed in a peridium which is sunk in the matrix, broadly obovate or pear-shaped, warted, the warts most numerous at the broad end of the spore, 40—50 × 25—33 μ.

Syn. *Uredo linearis*, var. *polypodii*, Pers.
Uredo filicum, Desm.
Uredo scolopendri, Fckl.

Parasitic on the fronds of various kinds of ferns. *Scolopendrium vulgare, Polypodium dryopteris, Blechnum spicant, Cystopteris fragilis, Adiantum capillus-veneris.*

PUCCINIA, Pers.

Pycnidia, when present, generally appearing on the upper surface of the leaf, subglobose, honey-colour; spores very minute, globose or elliptical, colourless.

Aecidia, when present, generally globose and closed when young, then expanding and becoming cup-shaped or cylindrical, usually with a distinct wall enclosing the spores, which are produced in chains, which soon break up, subglobose, wall usually colourless, contents orange or yellow.

Uredospores. Sori, when present, usually minute; spores produced singly on slender sporophores, subglobose or elliptical, germ-pores two or more, rarely only one.

Teleutospores. More or less elongated, 1-septate, borne singly on more or less elongated sporophores, frequently accompanied by paraphyses, each cell of the spore has one germ-pore. Produced in sori of variable size, usually blackish.

So far as the British Flora is concerned, the species of *Puccinia* are at once distinguished from all other members of the Uredinaceae by the constantly 2-celled teleutospores.

All the species are true parasites, and some prove very destructive to cultivated plants, as wheat rust, hollyhock disease, etc.

COMPOSITAE

ACHILLEA

Puccinia millefolii, Fuckel, Plowr., *Brit. Ured.*, p. 215.

Teleutospores. Sori minute, rounded or irregular, generally scattered, dusky brown, on both sides of the leaf; spores club-shaped or oblong club-shaped, tip rounded or slightly pointed, thickened, constricted at the septum, smooth, pale brown, 35—50 × 13—19 μ, pedicel stout, persistent, rather long. A few mesospores are sometimes found in a sorus of teleutospores.

On living leaves of yarrow—*Achillea millefolia*. Britain, Germany, Austria, Hungary, Italy, Belgium, and Holland.

ARTEMISIA

Puccinia absinthii, D.C

Uredospores. Sori minute, scattered or clustered, sometimes on minute yellowish spots, rounded or rarely elongated, powdery, pale brown; spores subglobose or elliptical, echinulate, yellow or pale yellowish-brown, 20—35 × 15—26 μ.

Teleutospores. Sori on both sides of the leaf, and sometimes on the stem, scattered or clustered, roundish, soon naked, blackish; spores oblong, elliptic-oblong or oblong club-shaped, tip rounded and thickened, constricted at the septum, upper cell minutely warted, lower cell often smooth, brown, 38—60 × 20—27 μ, pedicel stout, persistent, long.

Syn. *Uredo artemisiae,* Berk.

Trichobasis artemisiae, Berk.

On various species of *Artemisia.* Britain, Europe generally, Siberia, N. America, and Japan.

ASTER

Puccinia asteris, Duby, Plowr., *Ured.,* p. 215.

Teleutospores. Sori scattered or concentric on variously coloured spots on the under surface of the leaf, compact, blackish-brown; spores club-shaped or oblong club-shaped, tip rounded or somewhat pointed, much thickened, slightly constricted at the septum, and narrowed below, smooth, brown, 35—60 × 14—24 μ, pedicel persistent, thick, long, sometimes a few mesospores are present.

Syn. *Puccinia tripolii,* Cke.

On living leaves of *Aster tripolium,* and on various cultivated Asters. Britain, Europe generally, Siberia, and N. America.

CARDUUS

Puccinia carduorum, Jacky.

Uredospores. Sori scattered, minute, cinnamon, powdery; spores globose or subglobose, echinulate, pale brown, 22—28 μ diam.

Teleutospores. Sori similar to those of the uredospore, dark brown; spores very variable, ovate, elliptical or oblong, tip rounded, not thickened, not at all, or scarcely constricted at the septum, base generally rounded, minutely warted, epispore thin, 25—28 × 17—24 μ, pedicel short.

On living leaves of *Carduus crispus, C. nutans* and *C. acanthoides.* Britain, Europe generally, and Siberia.

Characterised by the warted teleutospore, amongst the species on *Carduus*.

Puccinia cardui-pycnocephali, Sydow.

Uredospores. Sori produced on the under surface of the leaves, scattered, minute, pale brown, not causing discoloured spots ; spores globose or subglobose, very minutely echinulate, 22—26 μ diam.

Teleutospores. Sori on the under surface of the leaves, scattered, and almost hidden by the down on the leaf, not forming discoloured spots, brown, somewhat darker than the uredospore sori ; spores oblong, tip rounded, not thickened, not at all, or very slightly constricted at the septum, base rounded, epispore thin, smooth, pale brown, 38—50 × 16—23 μ, pedicel hyaline, slender, deciduous, up to 40 μ long.

On living leaves and stem of *Carduus pycnocephalus*, L. First observed in this country by Dr. Eng. Mayor, at Sidmouth, July, 1907. During August of the same year, I collected the fungus in abundance, on the same host, along the coast-line between Eastbourne and Hastings.

Previously only recorded from Italy on *C. pycnocephalus*, L.

Some specimens collected agreed well with the diagnosis given above, while other specimens approach very closely to a second species of *Puccinia*, described by Sydow as parasitic upon *C. pycnocephalus*, L., and called *P. galatica*, Sydow, of which the following is a diagnosis :

Uredospores. Spores found mixed with the teleutospores, globose or subglobose, pale brown, minutely echinulate, 22—28 μ diam.

Teleutospores. Sori occurring on both surfaces of leaves, not forming discoloured spots, scattered or gregarious, minute, black, becoming pulverulent ; spores elliptical, ends rounded, tip not thickened, generally slightly constricted at the septum, dusky brown, epispore about 3 μ thick, delicately punctate, 30—45 × 22—28 μ, pedicel hyaline, slender, up to 30 μ long.

Distinguished from *P. cardui-pycnocephali*, Syd., by the slightly smaller, darker coloured, thick-walled teleutospores.

On living leaves of *Carduus pycnocephalus*, L., var. *albidus*. Asia Minor.

CARLINA

Puccinia carlinae, Jacky.

Uredospores. Sori scattered, minute, powdery, brown,

not forming spots, on both surfaces of the leaf; spores globose or subglobose, very minutely echinulate, pale brown, 24—30 × 20—25 μ.

Teleutospores. Sori minute, scattered, powdery, blackish, not forming spots, on both sides of the leaf; spores elliptical or ovate-oblong, tip rounded, not thickened, scarcely or not at all constricted at the septum, very minutely warted, brown, 26—40 × 16—22 μ, pedicel short.

On leaves of *Carlina acaulis*. Britain, Europe generally, except France.

CENTAUREA

Puccinia cyani, Pass.

Uredospores. Sori usually on the under side of the leaf, not forming spots, minute, scattered or crowded, circular or elliptical, cinnamon colour, becoming powdery; spores globose, subglobose or broadly ovate, minutely echinulate, yellowish-brown, 20—30 × 19—24 μ.

Teleutospores. Sori present on both sides of the leaf, scattered, minute, dot-like, dusky brown, becoming powdery; spores broadly elliptical, rounded at both ends, apex not thickened, not constricted at the septum, very minutely warted, chestnut-brown, 30—35 × 22—27 μ; rarely up to 40 μ long; pedicel colourless, short.

Syn. *Uredo cyani*, Schleich.

Puccinia suaveolens, forma *cyani*, Wallr.; Plowr., *Brit. Ured.*, p. 183.

Parasitic on living leaves and stem of *Centaurea cyanea*. Britain, Europe generally.

There are two generations during the year in this species. The perennial mycelium in the persistent portions of the host-plant, grows up along with the above-ground parts of the host, and becomes generally diffused, and gives origin to the first generation of uredo and teleutospores. Those of the second generation, appearing later in the season, are due to infection by uredospores of the first generation. The mycelium of the second generation is localised.

The uredospores have two equatorial germ-pores.

Puccinia centaureae, Mart.; Plowr., *Ured.*, p. 186.

Pycnidia. Grouped on yellow spots, circular on the leaves, elongated and bounded by a purple line on the leafstalks.

Uredospores. Sori minute, scattered or clustered, often on yellowish spots, powdery, brown; spores subglobose

or ellipsoid, echinulate, brown, 20—31 × 16—28 μ, generally on the under surface of the leaf.

Teleutospores. Sori minute, often crowded into each other, powdery, blackish, on both surfaces of the leaf; spores elliptical or pear-shaped, rounded at both ends, tip not thickened, scarcely constricted at the septum, very minutely warted, 25—50 × 18—30 μ, pedicel usually very short.

On *Centaurea nigra*. Britain, Europe generally, Siberia, Asia Minor and United States.

The sori of the primary uredospores are scanty, and often surrounded by the pycnidia.

CHRYSANTHEMUM

Puccinia chrysanthemi, Roze.

Uredospores. Sori scattered or clustered on pale spots, sometimes arranged in circles and spots not evident, powdery, cinnamon; spores subglobose or elliptical, echinulate, brown, 24—32 × 14—17 μ.

Teleutospores. Mixed with uredospores and following on, elliptical or elliptic-oblong, tip rounded and slightly thickened, scarcely constricted at the septum, minutely warted, chestnut-brown, 35—43 × 20—25 μ, pedicel stout, long.

Mesospores. Subglobose or pear-shaped, tip rounded and slightly thickened, very minutely warted, chestnut colour.

On living leaves of cultivated species of *Chrysanthemum*. Some few years ago this fungus assumed an epidermic form, and for a time threatened to render the cultivation of the *Chrysanthemum* impossible.

CICHORIUM

Puccinia cichoria, Bell.

Uredospores. Sori minute, scattered or in groups, on both surfaces of the leaf and on the stem, powdery, cinnamon; spores subglobose or elliptical, echinulate, yellowish brown, 21—27 μ diam.

Teleutospores. Sori like those of uredospore, on both surfaces of the leaf and on the stem, blackish brown; spores elliptical, tip rounded, not thickened, scarcely constricted at the septum, base generally rounded, smooth, brown, 27—38 × 19—25 μ, epispore thin, pedicel short.

On living leaves and stem of chicory—*Cichoria intybus*. Britain, Europe generally.

The uredospores have two germ-pores.

CIRSIUM

Puccinia obtegens, Tul.

Pycnidia. Crowded over the entire under surface of the leaf, emitting a pleasant odour resembling honey. Sori of uredospores and teleutospores of the first generation minute, crowded and often encroaching on each other, minute, powdery, brown then dusky, occupying the entire under surface of the leaf.

Uredospores. Second generation; sori hypophyllous, minute scattered; spores globose, subglobose or broadly elliptical, echinulate, pale brown, 21—28 μ diam.

Teleutospores. Second generation; sori hypophyllous, minute, scattered, blackish-brown, elliptical or ovate-elliptical, rounded at both ends, or slightly narrowed at the base, tip not thickened, little or not at all constricted at the septum, very minutely warted, brown, epispore thin, 26—42 × 17—25 μ; pedicel short, slender, colourless.

Syn. *Caeoma obtegens,* Link.
Caeoma seoavlens, Link.
Uredo suaveolens, Pers.
Puccinia obtegens, Fuckel.
Puccinia suaveolens, Rostr.; Plowr., p. 182.
Trichobasis suaveolens, Lév.

Parasitic on leaves and stem of *Cnicus arvensis,* Hoffm. (=*Carduus arvensis*), (=*Cirsium arvensis*). Europe, N. America.

The mycelium is perennial in the rootstock, and gives origin, each season, to the pycnidia, and the uredospores and teleutospores of the first generation. The second generation of uredospores and teleutospores—there are no pycnidia—are the result of infection by the uredospores of the first generation. The mycelium of this generation is localised.

The pleasant odour, remarked from early times by mycologists, when the leaves of an infected plant are rubbed, is produced by the contents of the pycnidia (spermogonia). The uredospores have three germ-pores.

Diseased plants appear earlier in the season than healthy ones, and are readily recognised by the sickly pale yellowish-green colour of the leaves, which stand very erect, no flowers are produced by infected plants.

The variety mentioned by Plowright, as occurring on *Centaurea cyanus*, L., is here described under *Puccinia cyani*, Pass.

Puccinia cirsii, Lasch.

Uredospores. Sori scattered or clustered, minute, soon naked and powdery, cinnamon; spores subglobose, elliptical, etc., echinulate, pale brown, 22—28 × 19—24 μ.

Teleutospores. Sori similar to those of the uredospores, blackish, on both surfaces of the leaf; spores elliptical, apex rounded and not thickened, scarcely constricted at the septum, base usually rounded, very minutely warted, chestnut-brown, 25—38 × 17—25 μ, epispore thin, pedicel very short.

On *Cirsium acaulis* and *C. heterophyllum*. The uredospores have three germ-pores.

Puccinia andersonii, B. and Br.

Teleutospores. Sori minute, compact, usually crowded on circular, yellowish spots surrounded by a brown border, on the under surface of the leaf, blackish-violet, often almost concealed by the down on the leaf; spores elliptic-oblong or club-shaped, constricted at the septum, smooth, brown, upper cell usually darkest in colour, tip rounded or pointed and thickened, 45—55 × 17—24 μ, paraphyses absent.

On leaves of *Cirsium heterophyllus* (= *Carduus heterophyllus*). Britain, Austria, Switzerland, Denmark, Lapland, Finland, and Russia.

Puccinia cnici-oleracei, Pers.

Teleutospores. Sori minute, circinate or in clusters on large circular spots on the under surface of the leaf, for a long time covered by the epidermis, forming pale spots on the opposite side of the leaf; spores spindle-shaped or club-shaped, much constricted at the septum, tip rounded or rarely conical, much thickened, base narrowed, smooth, yellowish-brown, 38—56 × 15—20 μ, pedicel stout, long.

Syn. *Puccinia cardui*, Plowr.

On *Cirsium lanceolatum* (=*Carduus lanceolatus*), *C. crispus*.

CREPIS

Puccinia major, Diet.

Pycnidia. On yellow or reddish spots on the under surface of the leaf.

Aecidia. On rounded spots on the under surface of the leaves, or in oblong clusters on the nerves and leafstalks,

small, with a white, torn recurved edge ; spores minutely warted, orange, 20—30 × 16—24 μ.

Uredospores. Sori minute, cinnamon, on both sides of the leaf ; spores subglobose or elliptical, echinulate, brown, 24—30 × 21—26 μ.

Teleutospores. Sori minute, mostly solitary, often on minute yellowish spots, on both sides of the leaf, dusky brown ; spores elliptical or ovoid, ends rounded, tip not thickened, slightly constricted at the septum, very minutely warted, chestnut-brown, 33—48 × 22—30 μ, epispore thin, pedicel short.

Syn. *Puccinia lapsanae,* Fckl. ; Plowr., *Ured.,* p. 148.

On leaves of *Crepis paludosa* and *Lapsana communis.*

Puccinia intybi, Syd.

Aecidia. Scattered or in small groups on the under surface of the leaves, cup-shaped, yellow, with whitish, reflexed, torn edges ; spores subglobose, very minutely warted, orange, 19—25 × 15—20 μ.

Uredospores. Sori scattered, minute, usually most developed on the upper surface of the leaf, powdery, cinnamon ; spores subglobose, echinulate, chestnut-brown, 24—30 μ diam.

Teleutospores. Sori similar to those of the uredospores, dusky brown ; spores elliptical or oblong, rounded at both ends, tip not thickened, scarcely constricted at the septum, minutely warted, dark brown, 25—37 × 15—22 μ, epispore thin, pedicel very short as a rule.

Syn. *Puccinia variabilis,* var. *intybi,* Juel.

On living leaves of *Crepis praemorsa.* Britain and Germany.

HELIANTHUS

Puccinia helianthi, Schw.

Uredospores. Sori scattered or clustered, powdery, cinnamon, mostly on the under surface of the leaf ; spores subglobose or ellipsoid, aculeate, yellowish-brown, 22—27 μ.

Teleutospores. Sori scattered or clustered, pulvinate, compact, dusky, generally on the under surface of the leaf ; spores elliptical or oblong, tip thickened and pale, constricted at the septum, base rounded, smooth, brown, 35 × 52 × 20—27 μ, pedicel stout, long, persistent.

On leaves of cultivated sunflower—*Helianthus annuus.* Britain, Europe generally, on various species of *Helianthus* ; N. America.

HIERACIUM

Puccinia hieracii, Mart.

Uredospores. Sori usually scattered, minute, soon naked, powdery, cinnamon, on both surfaces of the leaf, but most numerous on the upper side; spores echinulate, yellowish-brown, 24—29 × 16—25 μ.

Teleutospores. Sori similar to those of the uredospores, blackish-brown; spores elliptical or ovate-elliptical, tip rounded, not thickened, scarcely constricted at the septum, base rounded, rarely narrowed, very minutely warted, brown 25—40 × 16—24 μ, pedicel generally very short.

Syn. *Puccinia hieracii,* Plow., *Ured.,* p. 184 (in part).

On *Hieracium vulgatum, H. murorum, H. pilosella,* and other species of *Hieracium.* Britain and Europe generally; Asia, N. America.

Confined to the genus *Hieracium.*

HYPOCHOERIS

Puccinia hypochoeridis, Oud.

Uredospores. Sori scattered, powdery, cinnamon, on minute spots, on both sides of the leaf and on the stem, the primary sori are of medium size, the secondary sori are minute; spores subglobose or ellipsoid, echinulate, pale brown, 22—28 μ.

Teleutospores. Sori scattered, minute, on both surfaces of the leaf, larger on the stem, powdery, black; spores elliptical, tip rounded, not thickened, scarcely constricted at the septum, base rounded or rarely narrowed, very minutely warted, brown, 30—46 × 18—24 μ, pedicel short.

On leaves and stem of *Hypochoeris glabra, H. radicata,* and other species of *Hypochoeris.* Britain, Europe generally, Siberia, N. and S. America.

LACTUCA

Puccinia prenanthis, Lindr.; Plowr., *Ured.,* p. 148 (in part).

Aecidia. On large yellow or purplish spots, often elongated on the veins, hemispherical then flattened, yellow, whitish, or sometimes tinged purple; spores minutely warted, pale orange, 13—25 μ diam.

Uredospores. Sori scattered, minute, powdery, pale brown, on pale spots of variable size on the under surface of the leaf; spores subglobose, echinulate, yellow-brown, 15—25 μ diam.

Teleutospores. Sori similar to those of the uredospores, blackish-brown ; spores elliptical, tip rounded, not thickened, not constricted at the septum, base generally rounded, very minutely warted, brown, 25—40 × 15—25 μ, pedicel very short.

Syn. *Uredo prenanthis,* Schum.
Aecidium prenanthis, Pers.
Puccinia chondrillae, Fuckel.

On living leaves of *Lactuca muralis.* Britain and Europe generally.

The uredospores have three, rarely four, very distinct germ-pores.

LAMPSANA

Puccinia lampsanae, Fuckel.

Pycnidia. On crowded circular or elongated patches.

Aecidia. Flattened, white, edge reflexed, torn ; spores subglobose, almost smooth, orange, 16—21 × 13—17 μ, on rather large purplish spots.

Uredospores. Sori very numerous, circular, sometimes encroaching on each other, powdery, chestnut-brown, spores subglobose or ovate, minutely echinulate, pale brown, 17—22 × 15—18 μ.

Teleutospores. Sori minute, scattered, numerous, powdery, blackish ; spores elliptical or ovate, ends rounded, tip not thickened, very slightly constricted at the septum, very minutely punctate, chestnut-brown, 22—33 × 17—26 μ, pedicel slender, short, often oblique.

On *Lampsana communis* and *Crepis paludosa.* Britain, Europe generally, Syria, and Japan.

ARCTIUM (=Lappa)

Puccinia bardanae, Corda.

Uredospores. Sori large, flat, surrounded by the torn epidermis, powdery, cinnamon, scattered or clustered on spots on the upper surface of the leaf ; secondary sori small, scattered or clustered, not on spots, on both surfaces of the leaf ; spores subglobose or ellipsoid, echinulate, pale brown, 25—30 × 22—27 μ.

Teleutospores. Sori on both surfaces of the leaf, most abundant on the under surface, minute, scattered or clustered, not on spots, powdery, blackish ; spores elliptical, ends rounded, tip not thickened, usually slightly constricted at the septum, very minutely warted, dusky brown, 30—42 × 22—27 μ, pedicel short.

Syn. *Uredo bardanae*, Straus.
Puccinia lappae, Cast.

On various species of burdock—*Arctium*. Britain and Europe generally.

The uredospores have three, rarely four, germ-pores.

LEONTODON

Puccinia leontodonis, Jacky.

Uredospores. Sori scattered, minute, cinnamon, on both sides of the leaf ; spores subglobose or elliptical, echinulate, pale brown, 35 × 24—27 μ.

Teleutospores. Sori similar to those of the uredospores, blackish ; spores variable, generally elliptical, ovate-elliptical or oblong, tip rounded, not thickened, not at all, or very slightly constricted at the septum, very minutely warted, 30—40 × 21—27 μ, epispore thin, pedicel short.

Syn. *Uredo apargiae*, Schleich.

On living leaves of various species of *Leontodon*. Britain and Europe generally.

PRENANTHES

Puccinia prenanthis-purpurae, Lindr.

Aecidia. In groups on more or less circular yellow or purplish-yellow, large spots, or on elongated spots following the veins, hemispherical then broadly open, yellow or whitish sometimes yellowish-purple ; spores subglobose or ellipsoid, very minutely warted, pale orange, 15—24 × 12—20 μ.

Uredospores. Sori scattered, very minute, on small yellowish spots on the under surface of the leaf, powdery, pale brown ; spores subglobose, minutely echinulate, yellowish, 17—25 μ diam.

Teleutospores. Sori similar to those of the uredospores, brown ; spores elliptical or ovate, tip rounded, not thickened, scarcely constricted at the septum, base generally rounded, very minutely warted, brown, 24—37 × 16—24 μ, epispore thin, pedicel short.

Syn. *Aecidium prenanthis*, Schm.
Puccinia prenanthis, Plowr., *Ured*., p. 148 (in part).

Confined to *Prenanthis purpurea*, an alien or escape from cultivation in this country. Britain and Europe generally.

The uredospore has three, rarely four germ-pores. This is practically a biological species, as there is little or no morphological distinction between the present and *P.*

prenanthis. The present species, however, will not infect species of *Lactuca*, but is confined to *Prenanthes*.

SENECIO

Puccinia expansa, Link.

Teleutospores. Sori in crowded groups on more or less circular, yellowish or brownish large spots, on both sides of the leaf, but most abundant on the under surface, blackish-brown ; spores ovate or broadly elliptical, ends broadly rounded, with a small pale wart at the tip, scarcely constricted at the septum, smooth, brown, 30—40 × 19—30 μ, pedicel very short.

On *Senecio aquatica*. Britain, Austria, Hungary, Switzerland, Holland, and Italy.

This species is represented in Cooke's *Fung. Brit.* I, No. 37, and II, No. 236, and in Vize, *Fung. Brit.*, No. 21.

Puccinia glomerata, Grev. ; Plowr., *Ured*. p. 209.

Teleutospores. Sori crowded, or in rings on rather large, brownish spots on both surfaces of the leaf, for a long time covered by the epidermis, then becoming powdery, brown ; spores oblong or ovate-oblong, with a very minute pale wart at the tip, base rounded or slightly narrowed, scarcely constricted at the septum, smooth, pale brown, 30—45 × 16—24 μ, pedicel very short.

On living leaves of ragwort—*Senecio jacobaea*. Britain and Belgium.

Distinguished from *P. expansa* by the pale brown, oblong teleutospore, with a very minute pale wart at the tip, and by the host-plant, ragwort, to which it is confined.

Puccinia senecionis, Lib.; Plowr., *Ured*., p. 209.

Aecidia. On yellowish or brownish spots on the under surface of the leaf, solitary or in small clusters, flat, whitish, edge irregularly torn ; spores angularly globose, tinged yellow, punctate, 15—20 μ diam.

Teleutospores. Sori minute, in small groups covered by the epidermis, which becomes perforated at the centre, then powdery, dusky brown, on the under surface of the leaf ; spores ovate or broadly elliptical, ends rounded, tip not thickened, often with a small, pale wart, very slightly or not at all constricted at the septum, smooth, brown, 24—30 × 18—21 μ, pedicel very short, or practically absent.

On *Senecio aquatica*. Britain, Germany, Austria, Switzerland, France.

SOLIDAGO

Puccinia virgaureae, Lib.; Plowr., *Ured.*, p. 203.

Teleutospores. Sori minute in dense clusters on yellow spots with a purple or brown border, rounded, compact, often radiating, blackish; spores oblong, club-shaped or spindle-shaped, tip rounded or narrowed, much thickened and darker, not at all, or very slightly constricted at the septum, narrowed towards the base, smooth, yellowish brown, pale towards the base, 30—60 × 15—25 μ, pedicel about half as long as the spore.

On *Solidago virgaurea*—Golden-rod. Britain and Europe generally.

Plowright says the sori are surrounded by a thick bed of dark brown paraphyses.

SONCHUS

Puccinia sonchi, Rob.; Plowr., *Ured.*, p. 196..

Uredospores. Sori scattered or in small groups, on small yellowish spots, mostly on the under surface of the leaf, at first swollen and covered by the epidermis, then in a cup-shaped edging of the epidermis, yellow then brown or golden-brown; spores subglobose, elliptical or oblong, epispore thick, warted, yellowish, 24—38 × 15—21 μ.

Teleutospores. Sori scattered or arranged in rings, on irregular brown spots, covered by the epidermis, blackish, on the under surface of the leaf, rarely on the stem; spores elliptical or oblong, tip rounded, truncate or narrowed, thickened, slightly constricted at the septum, base rounded, or rarely narrowed, smooth, pale brown, 25—60 × 20—30 μ, pedicel rather long, brownish; mesospores numerous, ovate, clavate or oblong, tip thickened, brownish, 45—60 × 20—25 μ, paraphyses numerous, club-shaped, tip thickened.

On leaves and stem of sow-thistles—*Souchus arvensis*, *S. asper*, and *S. oleraceus*. Britain, Europe generally, Algeria, Canaries, and Japan.

TANACETUM

Puccinia tanaceti, D.C.; Plowr., *Ured.*, p. 189 (in part).

Uredospores. Sori scattered, minute, pale brown, sometimes on spots, on both sides of the leaf; spores subglobose or elliptical, echinulate, yellowish-brown, 25—32 × 16—25 μ.

Teleutospores. Scattered, minute, soon naked, blackish,

on both surfaces of the leaf; spores elliptical or oblong, tip rounded, thickened, base generally rounded, minutely warted, especially towards the tip, brown, 32—44 × 16—24 μ, pedicel thick, long, persistent.

On *Tanacetum vulgare*. Britain, Europe generally.

Plowright included *Puccinia artemiseae*, in the present species.

TARAXACUM

Puccinia variabilis, Grev.; Plowr., *Brit. Ured.*, p. 150.

Aecidia. On minute yellowish or purplish spots, scattered over the under surface of the leaf, less frequently on the upper side, solitary or in small groups, cup-shaped with white torn edges; spores orange, minutely warted, 20—25 × 15—20 μ.

Uredospores. Sori small, rounded or elongated, scattered, minute, soon naked, brown, on minute purplish spots on both sides of the leaf; spores subglobose or ovate, echinulate, brown, 20—35 × 15—25 μ.

Teleutospores. Sori similar to those of the uredospores, dark brown; spores, oval, oblong or subglobose, tip rounded, not thickened, scarcely constricted at the septum, very minutely warted, brown, 25—50 × 20—28 μ, pedicel as long as the spore, but deciduous. Both forms of spore often met with in the same sorus.

Syn. *Aecidium taraxici*, Grev.

Aecidium grevillei, Grove.

On *Taraxacum officinale*. Britain, Sweden.

Puccinia taraxici, Plowr., *Ured.*, p. 186.

Pycnidia. On yellow, oval or circular spots.

Uredospores. Primary, sori few, large, dark brown, elongated or in rings; spores ovate, globose or pear-shaped, echinulate, brown, 25—30 × 25 μ. Secondary; sori very small, numerous, round, often confluent, soon powdery, brown, echinulate, 20—25 μ diam., with two germ-pores.

Teleutospores. Sori minute, circular, powdery, surrounded by the torn epidermis, blackish, on both sides of the leaf; spores shortly oval or subglobose, tip rounded, not thickened, scarcely constricted at the septum, brown, echinulate, especially above, epispore thin, 25—40 × 16—25 μ, pedicel short.

Syn. *Puccinia phaseoli*, var. *taraxici*, Rebent.

On *Taraxacum officinale*. Britain, Europe generally, N. America, India, Japan.

This is a much more common species than *Puccinia variabilis*.

TRAGOPOGON

Puccinia tragopogi, Corda ; Plowr., *Ured.*, p. 196.

Pycnidia. On the under surface of the leaf.

Aecidia. Often covering every part of the plant, on the under surface of the leaf, no spots, shortly cylindrical then cup-shaped, edge white, recurved, torn, white ; spores subglobose or elliptical, minutely but densely warted, pale orange, 20—35 × 18 × 25 μ.

Teleutospores. Sori minute, scattered, or here and there in small groups, no distinct spots, on both surfaces of the leaf, becoming powdery, blackish ; spores subelliptical or almost globose, generally slightly constricted at the septum, warted, chestnut-brown, 25—50 × 18—32 μ, pedicel short, a few uredospores are often mixed with the teleutospores, minutely spinulose, brownish, 24—30 μ diam.

Syn. *Aecidium tragopogi*, Pers.
Puccinia sparsa, Cooke.
Puccinia inquinans, Wallr., var. *tragopogonis*, Wallr.
Puccinia hysterium, Rohl.

On goatsbeard, *Tragopogon pratensis*. Britain, Europe generally, and Asia Minor.

The mycelium of the aecidiospores causes distortion of the host, whereas the mycelium of the teleutospores is localised. The mycelium is perennial in the rootstock.

CAMPANULACEAE

CAMPANULA

Puccinia campanulae, Carm.; Plowr., *Ured.*, p. 200.

Teleutospores. Sori small, brown, scattered or in rings, for a long time covered by the epidermis, sometimes crowded into each other, on the under surface of the leaf, rarely on the upper surface ; spores elliptical, ovate or oblong, tip with a flattened or wart-like thickening, which is generally brown, base rounded or slightly narrowed, yellowish-brown, 24—50 × 15—25 μ, pedicel slender, about the length of the spore, soon disappearing.

On leaves, leafstalks and stem of *Campanula rotundifolia* and *C. rapunculus*. Britain, Germany, Austria, Belgium, Sweden.

ADOXACEAE

ADOXA

Puccinia adoxae, Hedw.

Pycnidia. Scattered amongst the aecidia.

Aecidia. Scattered over the entire plant, cylindrical then expanded, edge deeply torn and recurved, white; spores subglobose or angularly globose, granular, yellowish, 15—22 μ diam.

Uredospores. Sori small, scattered, for a long time covered by the epidermis, cinnamon; spores subglobose, elliptical or ovoid, echinulate, pale brown, 20—30 × 16—20 μ.

Teleutospores. Sori small, blackish, often in rings on the leaves, and in lines on the stem, powdery; spores elliptical, ovate or somewhat spindle-shaped, narrowed at both ends, scarcely constricted at the septum, tip with a pale conical wart as a rule, smooth, chestnut-brown, 24—45 × 15—24 μ, pedicel usually short.

Syn. *Aecidium adoxae,* Duby.
Aecidium albescens, Grev.
Puccinia albescens, Grev.; Plowr., *Ured.,* p. 153.
Puccinia adoxae, Fckl.; Plowr., *Ured.,* p. 207.

On leaves, leafstalks and stem of *Adoxa moschatellina.* Britain, Europe generally, and N. America.

The uredospore form is rare. The aecidial and teleutospore stages often occur separately on different plants. Experiments have shown that *Puccinia adoxae* and *P. albescens* are one and the same fungus and not different species, as considered by Plowright. The mycelium is perennial in the host-plant.

RUBIACEAE

GALIUM

Puccinia punctata, Link.

Pycnidia. In small, honey-coloured groups.

Aecidia. Shortly cylindrical, edge recurved, white, on circular spots on the under surface of the leaf; spores globose or elliptical, orange-yellow, almost smooth, 15—25 μ diam.

Uredospores. Sori minute, often crowded, on the under surface of the leaf, chestnut-brown; spores globose, elliptical or ovate, minutely spinulose, brown, 22—30 × 17—23 μ.

Teleutospores. Sori black, circular or oblong, on the under surface of the leaf; teleutospores elliptical, oblong or clavate, tip very much thickened, slightly constricted at the septum, base narrowed, brown, smooth, 35—55 × 15—25 μ, pedicel thick, coloured, persistent.

Syn. *Puccinia galii*, Schw.; Plowr., *Ured.*, p. 143.
Puccinia galiorum, Link; Cooke, *Hdbk.*, p. 501.

On *Asperula odorata*, *Galium cruciatum*, *G. aparine*, *G. palustre*, *G. uliginosum*, *G. verum* and *G. mollugo*. Britain, Europe generally, Siberia, N. Americia, and Chili.

Puccinia valantiae, Pers.; Plowr., *Ured.*, p. 212.

Teleutospores. Sori scattered, in circles, or confluent in long, broad patches, yellowish, then brown, finally blackish; spores generally oblong spindle-shaped, narrowed at each end, tip much thickened, slightly constricted at the septum, smooth, pale brown, 40—65 × 15—18 μ, pedicel colourless, persistent, long.

Syn. *Puccinia acuminata*, Fckl.
Puccinia galii-cruciati, Johnst.

On leaves and stems of *Galium cruciatum*, *G. mollugo*, and *G. saxatile*.

Causing distortion and elongation of the stem.

Puccinia ambigua, Lagerh.

Aecidia. Solitary, or irregularly scattered over the whole under surface of the leaf, yellowish-white, edge recurved and torn; spores globose or polygonal, minutely warted, 13—15 μ diam.

Teleutospores. Sori on the under surface of the leaf and on the stem, small, elliptical, solitary or clustered, or in elongated patches on the stem, for a long time covered by the grey epidermis, then black, firm; spores elliptical, oblong or club-shaped, tip much thickened, slightly constricted at the septum, base narrowed, smooth, brown, 35—55 × 15—25 μ, pedicel long, brownish.

Syn. *Puccinia difformis*, Fckl.; Plowr., *Ured.*, p. 144 (in part).

On leaves and stem of *Galium aparine*. Britain, Europe, India, and N. America.

SCROPHULARIACEAE

VERONICA

Puccinia veronicae, Schroet.

Teleutopsores. Sori minute, in scattered, circular patches, yellowish-brown then brown, on roundish brown spots on the under surface of the leaf; spores spindle-shaped, tip generally rounded, thickened, base narrowed, scarcely constricted at the septum, yellowish or tinged brown, 28—36 × 10—12 μ, pedicel about the length of the spore as a rule.

Syn. *Uredo veronicae*, Schum.; Plowr., *Ured.*, p. 211.
On *Veronica montana* and *V. alpina*. Britain, Germany, Austria, Belgium, and Denmark.

Puccinia veronicarum, D.C.; Plowr., *Ured.*, p. 214.
Teleutospores. Sori minute, rounded, often crowded, compact then powdery, brown, on brown spots on the under surface of the leaf; spores oblong or somewhat spindle-shaped, tip narrowed, rarely rounded, very much thickened, constricted at the septum, base narrowed, smooth, chestnut-brown, 28—50 × 15—20 μ, pedicel usually tinged yellow, about as long as the spore.
Syn. *Caeoma veronicae*, Link. Britain and Europe generally.

LABIATAE

BETONICA

Puccinia betonicae, D.C.; Plowr., *Ured.*, p. 199.
Teleutospores. Sori minute, rounded, surrounded by the torn epidermis, on pale spots, usually occupying the greater portion of the under surface of the leaf, often crowded on the veins, powdery, dusky brown; spores elliptical or ovate, tip rounded, and with a small pale wart, slightly constricted at the septum, base rounded, smooth, yellowish-brown, 30—45 × 15—25 μ, pedicel slender, about equal in length to the spore.
Syn. *Uredo betonicae*, Str.
On *Betonica officinalis*. Britain and Europe generally.
The mycelium is perennial in the host-plant. Grove has figured abnormal, variously septate and distorted teleutospores, in Gard. *Chom.*, Aug. 8, 1885.

GLECHOMA

Puccinia glechomatis, D.C.; Plowr., *Ured.*, p. 214.
Teleutospores. Sori solitary, in circles, or in scattered groups, on brown patches on the under surface of the leaf, or in long patches on the leafstalk and stem, often causing distortion, yellow then chestnut, finally blackish; spores elliptical or oblong, with a prominent wart at the tip, or often oblique, not at all, or very slightly constricted at the septum, base rounded, smooth, brown, 30—50 × 15—30 μ, pedicel long, persistent.
Syn. *P. verrucosa*, Link.
On *Glechoma hederacea*. Britain, Europe generally, Siberia and Japan.

Plowright states that Prof. J. W. H. Trail has found this species (?) on *Prunella vulgaris* on Ben Lawers, in September.

MENTHA

Puccinia menthae, Pers.; Plowr., *Ured.*, p. 157.

Pycnidia. Scattered or arranged in small, honey-coloured clusters.

Aecidia. On the under surface of the leaves, and on the stem; on the leaves often in more or less regularly-arranged groups, on purplish-red spots; on the leafstalks and stem often forming long, swollen spots, opening irregularly, edge slightly torn, erect or slightly curved; spores subglobose, polygonal or elliptical, warted, pale yellow, 25—40 × 18—30 μ.

Uredospores. Sori minute, circular, scattered or in groups, cinnamon, on pale spots which soon disappear, on the under surface of the leaf; spores globose or elliptical, echinulate, pale brown, 15—30 × 14—28 μ.

Teleutospores. Sori minute, scattered or clustered, powdery, blackish, on the under surface of the leaf, rarely on the stem; spores elliptical, ovate or subglobose, with a broad pale wart at the tip, not at all, or very slightly constricted at the septum, minutely warted, dusky brown, 25—40 × 20—30 μ, pedicel slender, about as long as the spore.

Syn. *Uredo labiatarum,* D.C
Puccinia clinopodii, D.C.
Aecidium menthae, D.C.

On various species of *Mentha, Calamintha clinopodium,* and *Origanum vulgare.* Britain, Europe generally, Persia, India, Africa, and Japan.

The aecidial form causes much distortion of the stem, and stunting of the leaves of cultivated mint. The mycelium is perennial in the underground parts.

TEUCRIUM

Puccinia annularis, Schlecht.; Plowr., *Ured.*, p. 217.

Teleutospores. Sori at first minute, circular or oblong, covered by the epidermis, cinnamon when exposed, becoming coalescent in one or more circles round a central one, on yellowish or brownish spots on the under surface of the leaf; spores oblong, tip rounded and much thickened, sometimes truncate or narrowed, slightly constricted at the septum, base rounded or narrowed, smooth, pale yellowish-

brown, 30—55 × 15—25 μ, pedicel long, persistent, colourless.

On *Teucrium scorodonia*. Britain and Europe generally.

THYMUS

Puccinia caulinicola, Schneider.

Teleutospores. Sori minute, rounded or elongated, wart-like, and for a long time covered by the epidermis, then powdery and blackish-brown, mostly on the leafstalks and stem, rarely on the leaves; spores elliptical, ends rounded, tip not at all, or only slightly thickened, slightly constricted at the septum, smooth, pale brown, 25—35 × 15—25 μ, pedicel slender.

Syn. *Puccinia schneideri*, Schroet.; Plowr., *Ured.*, p. 201.

On *Thymus serpyllum*. Britain and Europe generally.

The mycelium is perennial, and causes the stems to elongate, and grow more erect than in the healthy, normal condition.

CONVOLVULUACEAE

CONVOLVULUS

Puccinia convolvuli, Cast.; Plowr., *Ured.*, p. 146.

Aecidia. In groups on the under surface of the leaves and forming elongated swellings on the stem and leafstalks, on brownish or purplish spots, edge white, broad, much torn; spores subglobose or angular, minutely warted, pale yellow, 18—30 μ diam.

Uredospores. Sori scattered or in rings, often crowded into each other, soon naked, brown; spores globose or subglobose, rarely elliptical or ovoid, echinulate, pale brown, 25—35 × 18—26 μ.

Teleutospores. Sori minute, often crowded together, covered for a long time by the grey epidermis, blackish brown, sometimes arranged in circles; spores oblong, oblong spindle-shaped or elliptical, tip blunt and slightly thickened, or more or less pointed and much thickened, base rounded or slightly narrowed, slightly constricted at the septum, smooth, chestnut-brown, 35—70 × 25—30 μ, pedicel brownish, stout. Messopores mostly ovoid with the tip much thickened, brown, 25—35 × 20—26 μ.

Sy . *Uredo sepium*, Spr.

Uredo betae, var. *convolvuli*, Pers.

On *Convolvulus sepium* and *C. arvensis*. Britain, Europe generally, Africa, Japan, and N. America.

APOCYNACEAE

VINCA

Puccinia vincae, Berk.; Plowr., *Ured.*, p. 161.

Pycnidia. On the underside of the leaves, minute, brownish, often mixed with the uredospores.

Uredospores. Sori scattered or in groups on the under surface of the leaf, irregular, powdery, surrounded by the ruptured epidermis, pale brown; spores subglobose, ovate or pear-shaped, aculeate, pale brown, 25—35 μ, or 20—46 × 16—24 μ.

Teleutospores. Sori minute, scattered or crowded, circular or irregular in form, powdery, surrounded by the torn epidermis, dusky brown, on the under surface of the leaf; spores elliptical or ovate, rounded at both ends, tip not at all, or very slightly thickened, with a paler wart, minutely warted, the warts often arranged to form an irregular network, yellowish-brown, 35—60 × 20—30 μ, pedicel colourless, rather long, deciduous.

Syn. *Uredo vincae,* D.C.
Puccinia berkeleyi, Pass.
Trichobasis vincae, Cooke.

On *Vinca major.* Britain and Europe.

The pycnidia are sometimes scattered over the entire under surface of the leaves, and also occur on the stem. The leaves are stunted and fleshy in infected plants, in which the mycelium is perennial. Plowright describes an aecidial stage as follows. Sori pulvinate, not cup-shaped but discoidal, solid, 2—3 mm. in diameter, dark brown, with a greyish lustre. Spores globose, finely echinulate, colourless, 10—12 μ diam.

GENTIANACEAE

GENTIANA

Puccinia gentianae, Link.; Plowr., *Ured.*, p. 147.

Pycnidia. In scattered groups, honey-colour.

Aecidia. In irregular groups on circular brownish spots on the under surface of the leaves and on the stem, cup-shaped, edge white, torn; spores sobglobose or polygonal, minutely warted, orange, 15—25 μ.

Uredospores. Sori minute, scattered or arranged in rings, at first covered by the raised epidermis, circular, pale chestnut, on both sides of the leaves, but more especially on the upper surface; spores globose, subglobose

or broadly elliptical, minutely aculeate, pale brown, 20—35 × 18—24 μ.

Teleutospores. Sori minute, dusky brown, at first covered by the raised epidermis, powdery, more or less scattered; spores eliptical or ovoid, both ends rounded, tip not thickened, not at all, or scarcely constricted at the septum, smooth, dusky chestnut, 30—40 × 20—25 μ, pedicel rather long, slender.

Syn. *Aecidium gentianae*, Jacz.

On *Gentiana acaulis*. Britain, Europe generally, India, N. America.

PRIMULACEAE

PRIMULA

Puccinia primulae, Duby; Plowr., *Ured.*, p. 159.

Aecidia. On the under surface of the leaf in groups, on yellowish spots, shortly cylindrical, edge white, broadly recurved, much torn; spores angularly globose, minutely warted, orange, 18—25 μ.

Uredospores. Sori minute, scattered or arranged in circles, soon naked, brown, on the under surface of the leaf; spores subglobose or ovoid, echinulate, pale brown, 25—30 μ.

Teleutospores. Sori minute, circular, scattered or arranged in circles, for a long time covered by the greyish epidermis, dusky brown; spore ovoid-elliptical, rarely oblong, rounded at the ends, tip somewhat thickened, slightly constricted at the septum, smooth, pale brown, 25—35 × 16—20 μ, pedicel short, colourless.

Syn. *Uredo primulae*, D.C.
Aecidium primulae, D.C.
Trichobasis primulae, Cke.

On *Primula officinalis*, and on some cultivated species of *Primula*. Britain, Europe generally.

SOLDANELLA

Puccinia soldanellae, Fckl.; Plowr., *Ured.*, p. 159.

Pycnidia. Numerous, point-like dots.

Aecidia. Usually scattered over the under surface of the leaf, shortly cylindrical or cup-shaped, edge white, recurved, toothed; spores subglobose, minutely warted, yellow, 18—30 μ diam.

Uredospores. Sori minute, scattered or in rings, brown, mostly on the upper surface of the leaf; spores subglobose

or elliptical, echinulate, pale brown, epispore thick, 20—30 × 18—28 μ.

Teleutospores. Sori similar to those of the uredospores, dusky brown; spores elliptical, ovate-oblong or oblong, tip with a broad, paler wart, slightly constricted at the septum, base rounded or narrowed, smooth, brown, 35—55 × 20—35 μ, pedicel rather long, colourless, deciduous.

On *Soldanella alpina.* Britain, Germany, Austria, Hungary, France, Italy, and Switzerland.

UMBELLIFERAE

AEGOPODIUM

Puccinia aegopodii, Mart.; Plowr., *Ured.*, p. 201.

Teleutospores. Sori minute, usually in dense groups, at first covered by the epidermis, then naked and powdery, dusky brown, on yellowish, slightly thickened spots on both sides of the leaves, more especially along the veins, and on the leafstalks; spores ovate, elliptical or oblong, sometimes irregularly angular, tip rounded or narrowed, with a pale wart, base rounded, narrowed, scarcely constricted at the septum, smooth, chestnut-brown, 25—50 × 18—25 μ, pedicel short, slender, colourless.

Syn. *Uredo aegopodii*, Schum.

On goutweed—*Aegopodium podagraria.* Britain and Europe generally.

Infected plants show the leaves and stem often much distorted.

ANGELICA

Puccinia angelicae, Fuckel.

Uredospores. Primary; sori in minute groups, especially on the veins and leafstalks, deep yellow, finally dark brown. Secondary; sori minute, scattered on pale spots mostly on the under surface of the leaves, powdery, yellowish-cinnamon; spores ovate, elliptical or ovate-oblong, tip much thickened, pale brown, 25—40 × 22—28 μ, with three germ-pores.

Teleutospores. Sori scattered, minute, circular, powdery, blackish, usually on both surfaces of the leaf; spores elliptic-oblong or oblong, tip rounded, scarcely thickened, not at all, or very slightly constricted at the septum, base rounded or slightly narrowed, smooth, brown, 30—50 × 16—24 μ, pedicel short, deciduous.

Syn. *Uredo angelicae*, Schum, Berk.; *Brit. Fung.*, No. 221.

On *Angelica archangelica.* Britain, Europe generally, Turkestan.

APIUM

Puccinia apii, Desm.; Plowr., *Ured.*, p. 156.

Aecidia. On circular yellow spots on the under surface of the leaves, often elongated on the stem and leafstalks, very shortly cylindrical, edge white, torn; spores subglobose, minutely warted, orange, 17—25 μ diam.

Uredospores. Sori scattered, or here and there clustered, powdery, cinnamon-brown, on the under surface of the leaf; subglobose or elliptical, echinulate, tip slightly thickened, yellowish-brown, 24—35 × 20—26 μ, with three germ-spores.

Teleutospores. Sori mostly on the upper surface of the leaf, or on the leafstalks, scattered, or here and there in groups, powdery, dusky-brown; spores oblong or ovate-oblong, tip rounded, not thickened, slightly or not at all constricted at the septum, base rounded or slightly narrowed, smooth, brown, 30—50 × 18—25 μ, pedicel slender, colourless, deciduous.

On *apium graveolens.* Britain, Europe generally, India, Japan, and Tasmania.

BUNIUM

Puccinia bulbocastani, Fuckel.

Aecidia. Occuring on the leaves, leafstalks and stem, frequently causing very marked distortions on the latter, cup-shaped or shortly cylindrical, edge white and irregularly torn; spores angularly globose, very minutely warted, yellow, 15—22 μ diam.

Teleutospores. Sori minute, circular, scattered, sometimes elongated on the leafstalks, for a long time covered by the epidermis, blackish; spores elliptical, or elliptic-oblong or ovate-oblong, tip rounded, not thickened, scarcely, or not at all constricted at the septum, base rounded or narrowed, with a very delicate network on the epispore, brown, 28—50 × 15—25 μ, pedicel slender, colourless, deciduous.

Syn. *Puccinia bunii,* Winter; Plowr., *Ured.*, p. 206.
Aecidium bunii, D.C.; Plowr., *Ured.*, p. 270.

On *Bunium flexuosum* (=*Conopodium denudatum, Bulbocastanum*). Britain, Europe generally, Algeria.

Puccinia tumida, Grev.

Teleutospores. Sori minute, but crowded into thickened crusts, for a long time covered by the epidermis, on the leaves and leafstalks, blackish or blackish-brown; spores elliptical or ovate-elliptical, tip rounded, not thickened, not

at all, or very slightly constricted at the septum, base generally rounded, smooth, brownish, 26—36 × 15—26 μ, pedicel short, deciduous.

The sori are much larger, crust-like, and cause more swelling and deformation of the host-plant, than in the case of *Puccinia bulbocastani*, Fuckel.

This species is represented in Cooke, *Fung. Brit.* 1, No. 39a, and in 2, No. 327.

On *Bunium flexuosum* (=*Conopodium denudatum*). Britain, France, Germany, Norway.

BUPLEURUM

Puccinia bupleuri-falcati, Winter.

Pycnidia. Numerous, scattered over the whole of the leaf, or sometimes singly.

Aecidia. Mostly on the upper surface of the leaves, and uniformly scattered over the entire surface, cup-shaped, edge recurved, white, torn ; spores globose, subglobose or elliptical, punctate, yellow, 15—25 μ diam.

Uredospores. Sori scattered, or here and there in circular groups, on minute, pale spots, cinnamon, on both surfaces of the leaves ; spores subglobose or elliptical, echinulate, yellowish-brown, 20—25 × 17—24 μ.

Teleutospores. Sori scattered, minute, circular or elliptical, on both surfaces of the leaves, often elongated on the leafstalks and stem, often covered by the grey epidermis, at length naked and dusky brown ; spores elliptical or oblong-elliptical, tip rounded, not at all, or very slightly thickened, not at all, or very slightly constricted at the septum, base generally rounded, smooth, brown, 30—50 × 18—30 μ, pedicel colourless, slender, deciduous.

On *Bupleurum tenuissimum.* Britain, Europe generally, Asia Minor, India, China.

CHAEROPHYLLUM

Puccinia chaerophylli, Purton.

Aecidia. On the leaves and leafstalks, more especially on the leafstalks and veins, where they occur in dense groups, cup-shaped, yellow ; spores angularly globose, warted, orange, 18—35 × 16—26 μ.

Uredospores. Sori minute, circular, powdery, cinnamon ; spores subglobose or elliptical, warted, with three equatorial germ-pores, echinulate, yellowish-brown, 20—30 × 18—25 μ.

Teleutospores. Sori scattered, minute, circular or oblong, elongated on the leafstalk, powdery, dusky brown; spores elliptical or oblong, ends rounded, tip not thickened, scarcely constricted at the septum, netted, brown or yellowish-brown, 24—36 × 16—25 μ, pedicel slender.

Syn. *Puccinia pimpinellae*, Strauss, in Plowr., *Ured.*, p. 155 (in part).

On *Anthriscus silvestris, Chaerophyllum temulum* and *Myrrhis odorata.* Britain and Europe generally.

CONIUM

Puccinia conii, Fuckel.

Uredospores. Sori minute, circular, scattered or rarely in clusters, powdery, pale cinnamon, on the under surface of the leaves, or on the leafstalks; spores subglobose or elliptical, tip echinulate and thickened, with three germ-pores, pale brownish-yellow, 24—36 × 17—26 μ.

Teleutospores. Sori similar to those of the uredospores, dusky brown, sometimes for a long time covered by the epidermis when on the petioles; spores ovate or oblong-ovate, tip rounded, scarcely thickened, scarcely constricted at the septum, almost smooth, pale brown, 30—50 × 20—30 μ, pedicel short, deciduous.

Distinguished from *Puccinia bullata*, Winter, by the uredospores being smooth, except at the thickened tip. In Berk., *Brit. Fung.*, No. 57, and in Cooke, *Fung. Brit.*, 1, No. 42; in 2, Nos. 319 and 328.

On *Conium maculatum.* Britain and Europe generally.

HERACLEUM

Puccinia heraclei, Grev.

Aecidia. In dense irregular or elongated clusters on the under surface of the leaves, more especially following the veins, very often also on the leafstalks, on slightly thickened yellowish or brownish spots, forming cup-shaped pustules, the wall scanty; spores angularly globose, minutely warted, yellowish, 21—32 × 18—28 μ.

Uredospores. Sori scattered, minute, chestnut-brown, on both surfaces of the leaf; spores subglobose or elliptical, densely echinulate, pale brown, 25—32 × 19—27 μ, with three or four germ-tubes.

Teleutospores. Sori minute, scattered, or more or less crowded and following the veins, powdery, blackish-brown; spores elliptical, ends rounded, very slightly constricted at

the septum, wall netted, brown, 26—37 × 18—27 μ, pedicel short, colourless, deciduous.

Syn. *Uredo aecidiiformis*, Grev.
Trichobasis heraclei, Berk.
Puccinia pimpinellae, Strauss.; Plowr., *Ured.*, p. 155 (in part).
Puccinia bullata, Schroet.; Plowr., *Ured.*, p. 183 (in part).

Differs from *Puccinia pimpinellae* in the uredospores having three or four germ-pores, and in the very imperfectly developed wall of the aecidium.

On leaves of *Heracleum sphondylium*. Britain and Europe generally.

HYDROCOTYLES,

Pucciuia hydrocotyles, Cooke; Plowr., *Ured.*, p. 195.

Aecidia. Cup-shaped, edge deeply cut, recurved, yellowish, often equally distributed over the under surface of the leaf, rarely solitary; spores angularly globose, punctate, tinged yellow, 19—26 μ diam.

Uredospores. Sori minute, for a long time covered by the epidermis, then naked, powdery, cinnamon, on both sides of the leaf, scattered or here and there in groups, often in a ring surrounding a central sorus; spores subglobose or elliptical, echinulate, brownish, 24—34 × 20—27 μ.

Teleutospores. Sori similar to those of the uredospores, blackish-brown; spores elliptical or elliptic-oblong, tip not at all, or only slightly thickened, slightly constricted at the septum, smooth or very minutely warted, brown, 30—44 × 18—28 μ, pedicel slender.

Syn. *Trichobasis hydrocotyles*, Cooke.

On *Hydrocotyle vulgaris*. Britain, Italy, France, Holland, N. and S. America, Natal.

PETROSELINUM

Puccinia petroselini, Lindr.

Uredospores. Sori very minute, scattered, or crowded into large patches, powdery, cinnamon, generally on the under surface of the leaf; spores subglobose or ellipsoid, echinulate all over, or sometimes almost smooth, tip thickened, yellowish or yellow-brown, 20—30 × 20—25 μ.

Teleutospores. Sori like those of the uredospores, dark brown, often elongated and crowded on the leafstalks; spores elliptical or ovate-elliptical, tip rounded, not thick-

ened, slightly constricted at the septum, base rounded or slightly narrowed, smooth, or almost smooth, brown, 28—50 × 18—25 μ, pedicel colourless, slender, deciduous.

Syn. *Puccinia bullata*, Schroet.; Plowr., *Ured.*, p. 183 (in part).

On *Aethusa cynapium*, and parsley, *Petroselinum sativum*. Britain and Europe generally.

PEUCEDANUM

Puccinia peucedani-parisiensis, Lindr.

Uredospores. Primary; sori generally on the under surface of the leaf, mostly on the veins and leafstalks, forming long patches, cinnamon. Secondary; sori very minute, scattered, for a long time covered by the epidermis, brown, on the under surface of the leaf; spores subglobose or elliptical, very minutely echinulate, tip more or less thickened, base also thickened, yellowish, three, rarely four germ-pores.

Teleutospores. Sori minute, on the under surface of the leaf, or crowded into long patches on the leafstalks, powdery, dusky; spores elliptic-oblong or elliptic club-shaped, tip rounded, scarcely thickened, slightly constricted at the septum, base slightly narrowed, minutely warted in lines, brownish, 35—52 × 19—28 μ, pedicel slender.

Syn. *Puccinia bullata*, Schroet.; Plowr., *Ured.*, p. 183 (in part).

On *Peucedanum*. Britain and Europe.

Puccinia bullata, Winter; Plowr., *Ured.*, p. 185 (in part).

Uredospores. Primary; generally on the veins and leafstalks, forming elongated patches, cinnamon. Secondary; on the under surface of the leaves, rarely on the upper side, sori scattered, minute, brown; spores subglobose or elliptical, echinulate, brown, tip more or less thickened, 25—40 × 18—28 μ, three, rarely four germ-pores.

Teleutospores. Sori resembling those of the uredospores, dusky; spores elliptical or oblong-elliptical, tip rounded, scarcely thickened, slightly constricted at the septum, base rounded or slightly narrowed, smooth, brown, 28—42 × 18—22 μ, pedicel slender, colourless.

On *Silaus pratensis* and *Peucedanum*. Britain, Europe, Asia Minor, N. America.

The old *Puccinia bullata* of authors is a collective species, combining several forms that are separable when the infection method is followed.

PIMPINELLA

Puccinia pimpinellae, Mart.; Plowr., *Ured.*, p. 155 (in part).

Pycnidia. On both surfaces of the leaf.

Aecidia. Following the veins on the under surface of the leaf, cup-shaped, edge irregularly torn, whitish; spores angularly globose, warted, tinged yellow, 22—28 × 20—26 μ.

Uredospores. Sori scattered, minute, powdery, cinnamon, on the under surface of the leaf; spores subglobose or ellipsoid, brown, 22—32 × 20—26 μ.

Teleutospores. Sori similar to those of the uredospores, dusky brown; spores elliptical, ends rounded, tip not thickened, not at all, or only very slightly constricted at the septum, netted, brown, 28—37 × 19—25 μ, pedicel colourless, deciduous.

Syn. *Puccinia umbelliferarum*, D.C.

On *Pimpinella magna* and *P. saxifragae.* Britain, Europe Asia Minor, India, Algeria.

The uredospore has two, rarely three germ-pores.

SANICULA

Puccinia saniculae, Grev.; Plowr., *Ured.*, p. 160.

Aecidia. Cup-shaped, edge white, recurved, torn, in groups on brown or reddish-purple spots on the under surface of the leaves, or in long clusters on the veins and leafstalks; spores angularly globose or elliptical, very minutely warted, colourless, 18—26 × 15—22 μ.

Uredospores. Sori minute, scattered, or rarely a few in loose clusters, pale cinnamon, on minute pale spots on the under surface of the leaves; spores subglobose or elliptical, echinulate, tip not thickened, brown, 25—40 × 18—30 μ, epispore thick, with two, rarely the germ-pores.

Teleutospores. Sori like those of the uredospores, but darker in colour; spores elliptic, oblong or ovate, tip rounded, slightly or not at all thickened, very slightly constricted at the septum, base rounded, or rarely slightly narrowed, smooth, brown, 26—45 × 18—26 μ, pedicel slender, short, deciduous.

Syn. *Aecidium saniculae*, Carm.

On *Sanicula europeae.* Britain and Europe generally.

SMYRNIUM

Puccinia smyrnii-olusatri, Lindr.

Pycnidia. Generally on the under surface of the leaves.

Aecidia. On the under surface of the leaf, on the leafstalks and on the stem; in rather large clusters on yellowish spots on the leaves, in long groups on the leafstalks and stem, cup-shaped, yellowish, edge not much torn; spores subglobose, elliptical or ovate, minutely warted, yellowish, 18—32 × 18—24 μ.

Teleutospores. Sori scattered or in small groups, minute, powdery, dusky brown, on minute, yellowish spots on the under surface of the leaf; spores elliptical, ovate or oblong, ends rounded, tip not thickened, very slightly constricted at the septum, rather coarsely and distantly warted, or the warts forming more or less of a ridged network, brown, 35—50 × 20—30 μ, pedicel colourless, thin, long, deciduous.

Syn. *Puccinia smyrnii*, Corda.; Plowr., *Ured.*, p. 199.
Trichobasis petroselini, Berk., var. *smyrnii*, Cooke.

On *Smyrnium olusatrum*. Britain, France, Italy, Greece, Turkey, Crete and Cyprus, Asia Minor, and Algeria.

The alien host plant is local in its occurrence in this country, hence the fungus is comparatively rare. I have collected it in abundance years ago on the slope just outside the entrance to the castle at Scarborough, and Mr. Roe informs me that it is yet to be found there.

OENOTHERACEAE

CIRCAEA

Puccinia circaeae, Pers.; Plowr., *Ured.*, p. 213.

Teleutospores. Sori minute, wart-like, yellowish, then brownish, finally blackish, scattered or in circles, or forming crust-like patches on the stem, on pale patches on the under surface of the leaves; spores generally spindle-shaped, tip much thickened, rounded or conical, very slightly constricted at the septum, narrowed into the pedicel, smooth, yellowish or pale brown, 25—45 × 10—15 μ, pedicel colourless, up to as long as the spore.

On leaves, leafstalks and stems of *Circaea lutetiana*. Britain, Europe, India, N. America.

Two forms of sori are produced. On the surface of the leaf the sori are in scattered and in small groups, or arranged in circles; the spores have a clear brown wall, and germinate at once. Following the veins, or on the stem, the sori often consist of crusts of crowded sori, dark brown in colour; the spores have a dark brown wall, and germinate the following spring.

EPILOBIUM

Puccinia epilobii-tetragoni, Winter.

Pycnidia. Scattered amongst the aecidia, honey-colour.

Aecidia. Usually covering the entire under surface of the leaves, scattered or crowded, flat, edge recurved, torn, whitish; spores angularly globose, very minutely warted, orange, 16—26 μ diam.

Uredospores. Sori powdery, chestnut-brown, scattered, or in rings, sometimes growing into each other, on the under surface of the leaves; spores globose, elliptical or ovate, echinulate, brown, 20—30 × 15—25 μ.

Teleutospores. Sori often in concentric rings, soon naked, powdery, dusky brown, on the under surface of the leaf; spores elliptical or ovoid, ends rounded, tip thickened, slightly constricted at the septum, smooth, brown, 25—40 × 16—25 μ, pedicel colourless, slender deciduous.

Syn. *Puccinia pulverulenta,* Grev.; Plowr., *Ured.,* p. 151.
Aecidium epilobii, D.C.
Trichobasis epilobii, Berk.

On *Epilobium angustifolium, E. hirsutum, E. parviflorum, E. roseum, E. tetragonum,* and *E. montanum.* Britain, Europe, and N. America.

The mycelium is perennial in the host-plant.

Puccinia epilobii, D.C.; Plowr., *Ured.,* p. 202.

Teleutospores. Sori circular, soon surrounded by the ruptured epidermis, powdery, reddish-brown or blackish-brown, scattered or crowded over the entire under surface of the leaf, rarely clustered; spores oblong or elliptical, ends rounded, rarely slightly narrowed at the base, tip not at all, or very slightly thickened, strongly constricted at the septum, very delicately warted, brownish, 30—50 × 18—25 μ, pedicel colourless, short.

On *Epilobium palustre.* Britain, Europe, and Greenland.

Known amongst the species parasitic on *Epilobium* by its habit, the sori being scattered over the entire under surface of the leaf.

VIOLACEAE

VIOLA

Puccinia violae, D.C.

Pycnidia. In small groups, yellowish honey-colour.

Aecidia. Present on every green part of the plant, in crowded clusters on more or less circular, concave, yellowish patches on the leaves, scattered on the stem,

edge white, revolute, irregularly torn ; spores subglobose, very minutely warted, orange, 16—28 × 12—20 μ.

Uredospores. Sori minute, soon naked, powdery, cinnamon or chestnut colour, scattered or in clusters on the under surface of the leaf ; spores subglobose or elliptical, echinulate, brownish, 25—30 × 20—25 μ.

Teleutospores. Sori minute, circular, powdery, dusky brown, solitary or in clusters on yellowish spots on the under surface of the leaves ; spores elliptical or elliptic-oblong, ends rounded, base sometimes slightly narrowed, tip thickened and paler, scarcely constricted at the septum, very delicately punctate, chestnut-brown, 25—45 × 18—25 μ, pedicel colourless, rather long, deciduous.

Syn. *Aecidium violae*, Schum.
Uredo violarum, Lév.
Granularia violae, Sow.
Puccinia violarum, Link.

On various wild and cultivated species of *Viola*. Britain, Europe, Siberia, Asia Minor, India, N. and S. America, Japan.

Puccinia depauperans, Sydow.

Aecidia. Produced on every green part of the plant, most abundant on the stem, and more or less irregularly scattered over the surface of the leaves, cup-shaped, edge revolute, white, torn ; spores subglobose or elliptical, smooth, orange, 18—24 × 15—20 μ.

Uredospores. Sori on both surfaces of the leaves, and on the stem, irregularly scattered or in clusters, spots none, for a long time covered by the lead-coloured epidermis, then powdery and cinnamon ; spores subglobose or elliptical, minutely echinulate, brownish, 20—30 μ diam.

Teleutospores. Sori similar to those of the uredospores, dusky brown ; spores elliptical or ovate, often irregular in form, tip rounded or slightly narrowed, slightly thickened, or with a minute, almost colourless wart, scarcely constricted at the septum, base generally rounded, smooth, brown, 22—34 × 16—22 μ, pedicel colourless, short.

Syn. *Aecidium depauperans*, Vize.
Puccinia aegra, Grove.

On the leaves and stem of *Viola tricolor, Viola cornuta, V. lutea*, and on cultivated species of *Viola*.

Britain, Germany, and Denmark.

The aecidia are most abundant on the stem and on the veins of the leaves, and are often present at midsummer,

along with the teleutospores, which is not the case with *Puccinia violae*.

The mycelium is perennial, infected plants becoming deformed and pale in colour.

Puccinia fergussoni, Berk. and Broome; Plowr., *Ured.*, p. 207.

Teleutospores. Sori on large, rounded or irregular, yellowish spots, on the under surface of the leaves, rarely on the upper surface, and on the leafstalks, densely clustered and often growing into each other, for a long time covered by the epidermis, then powdery and brown; spores irregular in form, generally oblong and narrowed at the ends, rarely rounded at the ends, tip thickened, slightly constricted at the septum, smooth, yellowish-brown, 30—50 × 15—20 μ, pedicel thin, colourless, deciduous.

Syn. *Puccinia nidificaus*, Magnus.

On *Viola palustris*. Britain, Europe, and N. America.

Distinguished amongst the species occurring on species of *Viola* by the large clusters of crowded sori.

BALSAMINACEAE

IMPATIENS

Puccinia argentata, Winter; Plowr., *Ured.*, p. 193.

Uredospores. Sori minute, powdery, scattered or in rings on yellowish spots on the under surface of the leaf, ochraceous or pale cinnamon colour; spores subglobose or broadly elliptical, very minutely echinulate, pale yellow, three to five germ-pores, 18—25 × 15—20 μ.

Teleutospores. Sori minute, more or less circular, soon naked, chestnut-brown, scattered or in rings on minute yellowish or brownish spots; spores elliptical, ovate or somewhat club-shaped, with a colourless, usually oblique point at the tip, not at all, or very slightly constricted at the septum, smooth, pale brown, 25—40 × 15—25 μ, pedicel colourless, short, slender.

Syn. *Puccinia noli-tangeris*, Corda.

On *Impatiens noli-me-tangere*, *I. fulva*, and other cultivated species. Britain, Europe, N. America, and Japan.

BUXACEAE

BUXUS

Puccinia buxi, D.C.; Plowr., *Ured.*, p. 217.

Teleutospores. Sori scattered or crowded, wart-like,

compact, soon naked, dusky brown, on both surfaces of the leaf and on the shoots, often on yellowish spots; spores oblong or oblong club-shaped, tip rounded, scarcely thickened, constricted at the septum, base rounded or narrowed, smooth, brown, 60—90 × 25—35 μ, pedicel colourless, persistent, up to 160 μ long.

Syn. *Dicaeoma buxi*, Gray.

On the common box tree—*Buxus sempervirens*. Britain, Europe, Persia.

Usually only occurring on the leaves, but under certain conditions, abundant on the young shoots. A fox cover of many acres, composed almost entirely of box, was completely checked in growth, and finally destroyed by this fungus, in Ireland.

MALVACEAE

MALVA

Puccinia malvacearum, Mont.; Plowr., *Ured.*, p. 212.

Teleutospores. Sori on the under surface of the leaf, rarely also a few on the upper surface, on the leafstalks, stem and fruit, scattered or more or less crowded, hemispherical or wart-like, compact, circular, brownish, then hoary from the presence of secondary spores, usually on small, yellowish spots; spores oblong or somewhat spindle-shaped, ends narrowed, tip rarely rounded, thickened, scarcely constricted at the septum, smooth, yellowish brown, 40—75 × 18—30 μ, pedicel colourless, persistent, up to 150 μ long.

On the hollyhock—*Althaea rosea*, and on all our mallows, also on cultivated species of *Abutilon*.

This fungus was first described from specimens collected in Chili in 1852. It afterwards occurred in Australia, and invaded Europe in 1869. For some years afterwards, owing to the epidemic caused by this fungus, the cultivation of the hollyhock was rendered practically impossible, now, however, the balance has been restored, and fungus and hollyhock both flourish. The fungus has spread to all our mallows.

ROSACEAE

PRUNUS

Puccinia pruni-spinosae, Pers.

Uredospores. Sori minute, generally rather densely scattered over the under surface of the leaf, mostly on minute, variously coloured spots, soon naked and powdery, cinnamon-brown; spores subglobose or ovate, apex not

thickened, mixed with numerous, yellowish-brown paraphyses swollen at the tip; mesospores mixed with the uredospores, ovoid or elongated pear-shaped, tip thickened and darker, densely echinulate, pale brown, 26—40 × 12—20 μ.

Teleutospores. Sori scattered on the under surface of the leaf, or more or less in clusters, minute, powdery, blackish-brown; spores elliptical, ovoid or oblong, composed of two almost globose cells, the lower one generally the smallest, tip not thickened, rather coarsely warted, especially the upper cell, 35—45 × 18—25 μ, pedicel short, colourless.

Syn. *Puccinia pruni*, Pers.; Plowr., *Ured.*, p. 192.
Puccinia prunorum, Link.
Trichobasis rhamni, Cooke.

On *Prunus spinosa*, *P. domestica*, *Amygdalus communis*, *Persica vulgaris*. Britain, Europe, Canary Islands, N. and S. America, S. Africa, Australia, and New Zealand.

The specimen named *Trichobasis rhamni*, by Cooke, and supposed to be parasitic on the leaves of *Rhamnus catharticus*, proves to be on the leaves of a *Prunus*.

Quite recently Biffen has proved by infection experiments that *Aecidium punctatum*, Pers., parasitic on *Anemone ranunculoides* (= *A. coronaria*), is the aecidial form of this species. The wide distribution of the teleutospore condition proves that the aecidial form is not necessary for its existence.

CRASSULACEAE

RHODIOLA

Puccinia rhodiolae, Berk. and Broome; Plowr., *Ured.*, p. 207.

Teleutospores. Sori on both sides of the leaves, and on the stem, most frequently on the under surface of the leaves, scattered or in crowded circular clusters on pale spots, for a long time covered by the epidermis, then powdery and dark brown; spores broadly elliptical, ends rounded, tip slightly or not at all thickened, smooth, chestnut-brown, 26—40 × 20—25 μ, pedicel, colourless, about as long as the spore.

Syn. *Puccinia blytii*, De Toni.

On *Rhodiola rosea* (= *Sedum rhodiola*). Britain and Norway.

UMBILICUS

Puccinia umbilici, Guep.; Plowr., *Ured.*, p. 204.

Teleutospores. Sori usually crowded on large more or less circular, pale or reddish spots, often in irregular circles, convex, compact, then powdery, reddish-brown, mostly on the leaves, sometimes on the leafstalks; spores broadly elliptical, ends rounded, tip not thickened, but often with a minute, pale point, scarcely constricted at the septum, smooth, clear brown, 28—40 × 20—28 μ, pedicel short, colourless.

On *Cotyledon umbilicus.* Britain, France, Belgium, Spain.

The sori are often 1cm. and more across, and surrounded by a reddish-purple zone. The colour on the opposite side of the leaf to where a sorus is situated, is often deep rosy-purple.

SAXIFRAGACEAE

CHRYSOSPLENIUM

Puccinia chrysosplenii; Grev., Plowr., *Ured.*, p. 211.

Teleutospores. Sori raised, brown, scattered or frequently in circular clusters, sometimes in concentric rings on both sides of the leaves, most frequently on the under surface; spores oblong, somewhat spindle-shaped or club-shaped, tip rounded or slightly narrowed, thickened, scarcely constricted at the septum, base generally narrowed into the pedicel, smooth, pale yellowish-brown, 25—45 × 14—18 μ, pedicel colourless, persistent, almost as long as the spore.

On *Chrysosplenium alternifolium* and on *C. oppositifolium.* Britain, Europe generally and Asia.

SAXIFRAGA

Puccinia saxifragae, Schlecht., Plowr., *Ured.*, p. 208.

Teleutospores. Sori generally on the under surface of the leaf, soon naked, powdery, dusky-brown, scattered or clustered, and often crowded into each other, on variously coloured spots; spores ovate, elliptical or oblong, tip conical or warted, thickened, scarcely constricted at the septum, base rounded or narrowed, with delicate longitudinal ridges, pale brown, 28—50 × 18—24 μ, pedicel rather long, slender, colourless, deciduous.

On *Saxifraga granulata, S. stellaris,* and on some cultivated species. Britain and Europe generally.

Puccinia pazschkei, Dietel.

Teleutospores. Sori epiphyllous, or rarely hypophyllous, usually arranged in irregular, concentric circles, here and there scattered, circular, margined by an irregular fringe of the ruptured epidermis, dark brown, becoming pulverulent ; spores elliptic-oblong, rounded at both ends, slightly constricted at the septum, apex very slightly thickened, not papillate, epispore pale, clear brown, distinctly warted, 30—45 × 15—20 μ ; pedicel hyaline, slender, about equalling the spore in length.

I have frequently found this species on living leaves of *Saxifraga longifolia,* Lapeyr., in Kew Gardens. Previously only known from Switzerland and Austria, upon *Saxifraga aizoon,* Jacq., *S. hostii,* Tausch., and *S. longifolia,* Lapeyr.

Has possibly been passed over in this country as *Puccinia saxifragae,* Schlecht., from which it differs in the warted epispore, and in other characters.

Puccinia huteri, Sydow, will also probably be found in this country. It occurs on living leaves of *Saxifraga mutata, L.,* Lapeyer, in Austria. Its characters are as follows :

Uredospores ?

Teleutospores. Sori on both surfaces of the leaf, scattered or gregarious, sometimes encroaching on each other, rounded or oblong, 1—2 mm. long, covered for a long time by the grey epidermis, becoming naked and pulverulent, dusky brown ; spores oblong, tip with a paler papilla up to 8 μ long, constricted at the septum, base rounded or narrowed, punctate, not striate, brown, 35—54 × 14—19 μ, pedicel colourless, slender.

GROSSULARIACEAE
GROSSULARIA

Puccinia ribis, D.C.

Teleutospores. Sori powdery, chestnut-brown, bordered by the torn epidermis, in circular groups, often crowded into each other, on yellowish or brownish spots, on the upper surface of the leaf ; spores elliptical or oblong, ends rounded, or the tip rarely narrowed, slightly thickened, scarcely constricted at the septum, warted, chestnut-brown, 25—45 × 18—25 μ, pedicel colourless, slender, about equal in length to the spore.

On gooseberry—*Ribes grossularia* ; black currant—

Ribes nigrum, and red currant—*Ribes rubrum*. Britain, Europe generally, and N. America.

Puccinia pringsheimiana, Klebahn.

Aecidia. On somewhat thickened, concave spots, yellow below, where the cups are situated, reddish above, more or less circular, sometimes also occurring on the fruit, shortly cylindrical, edge white, torn ; spores angularly globose, minutely echinulate, yellow, 15—25 μ diam.

Teleutospores. Sori forming elongated lines on the leaves and culm, powdery, blackish ; spores oblong club-shaped or oblong, tip much thickened, rounded or truncate, base often narrowed, smooth, 35—50 × 15—20 μ, pedicel rigid, persistent.

Aecidia on leaves and fruit of gooseberry—*Ribes grossularia*.

Teleutospores on *Carex acuta*.

Syn. *Aecidium grossulariae*, D.C.; Plowr., *Ured.*, p. 263 (both in part).

RANUNCULACEAE

ANEMONE

Puccinia fusca, Winter.

Teleutospores. Sori usually scattered over the entire under surface of the leaf, or here and there in groups, rarely on the upper surface of the leaf, circular or elliptical, soon naked and powdery, dusky brown ; spores strongly constricted at the septum, cells subglobose or elliptical, lower one sometimes ovate or club-shaped, coarsely warted, brown, 40—60 × 20—30 μ, pedicel colourless, up to 50 μ long. Mesospores are sometimes mixed with the teleutospores, 30—45 × 18—25 μ.

On *Anemone nemorosa*. Britain, Europe generally, Siberia, and N. America.

The mycelium is perennial in the rootstock of the host-plant.

CALTHA

Puccinia calthae, Link.; Plowr., *Ured.*, p. 145.

Pycnidia. Arranged in small clusters, honey-colour.

Aecidia. On the under surface of the leaf, in small groups on yellowish circular spots, also forming long clusters on the leafstalks, cup-shaped, edge recurved, whitish, torn ; spores angularly globose, minutely warted, orange, 21—28 μ diam.

Uredospores. Sori minute, scattered, circular, powdery,

chestnut colour ; spores subglobose or elliptical, echinulate, pale chestnut, 25—30 × 20—25 μ.

Teleutospores. Sori minute, irregularly scattered, powdery, dusky brown, on both surfaces of the leaf ; spores oblong club-shaped or spindle-shaped, tip usually with a pale, conical wart, scarcely constricted at the septum, smooth, chestnut-brown, 35—50 × 16—25 μ, pedicel persistent, colourless, thick, long.

Syn. *Aecidium calthae*, Grev.

On *Caltha palustris*. Britain, Europe, Siberia, N. America.

THALICTRUM

Puccinia thalictri, Chev., Plowr., *Ured.*, p. 206.

Teleutospores. Sori circular or elliptical, soon naked, powdery, dusky-brown, scattered or in groups, often occupying the entire under surface of the leaf ; spores strongly constricted at the septum, apical cell globose or broadly elliptical, lower cell globose, elliptical, obvoate or rarely club-shaped, generally narrower than the upper cell, tip not thickened, covered with large sharp-pointed warts, brown, 30—55 × 20—30 μ, pedicel colourless, deciduous.

Syn. *Puccinia tuberculata*, Koern.

On *Thalictrum flavum* and *T. minus*. Britain, Europe, Siberia, and N. America.

Plowright suspects that the mycelium is perennial in the host-plant.

CARYOPHYLLACEAE

ARENARIA

Puccinia arenariae, Winter; Plowr., *Ured.*, p. 210.

Teleutospores. Sori powdery, pale brown, then dusky brown, becoming greyish or hoary from the presence of numerous secondary spores, scattered, in rings or forming elongated crusts, on the under surface of the leaves and stem ; spores oblong spindle-shaped or club-shaped, tip rounded or more or less narrowed, thickened, slightly constricted at the septum, narrowed below, smooth, yellowish-brown, 35—55 × 15—25 μ, pedicel persistent, longish.

Syn. *Puccinia lychnidearum*, Link.

Puccinia moehringiae, Fuckel.

On *Agrostemma githago, Dianthus barbatus, Sagina apetala, S. procumbens, Stellaria media, S. holostea, S. uliginosa, Cerastium triviale, Arenaria serpyllifolia*. Britain Europe, Siberia, India, and N. and S. America.

SILENE

Puccinia silenes, Schroet.; Plowr., *Ured.*, p. 147.

Pycnidia. Arranged in small, honey-coloured clusters.

Aecidia. In small circular clusters, on pale spots on the under surface of the leaf, shortly cylindrical, whitish, edge torn ; spores subglobose or polygonal, very delicately warted, orange, 18—30 × 16—21 μ.

Uredospores. Sori scattered or in circular groups, sometimes growing into each other, minute, cinnamon-brown, on both sides of the leaf ; spores subglobose or elliptical, echinulate, pale brown, 25—30 × 20—25 μ.

Teleutospores. Sori minute, powdery, blackish-brown, scattered, or sometimes in groups, on both surfaces of the leaf ; spores elliptical or oblong, ends rounded, tip slightly thickened, very slightly constricted at the septum, smooth, chestnut-brown, 25—40 × 18—26 μ, pedicel short, colourless.

Syn. *Uredo behenis,* D.C.
Puccinia lychnidearum, Fuckel.
Aecidium behenis, D.C.

On leaves and stem of *Silene inflata* and *S. nutans.* Britain and Europe generally.

SPERGULA

Puccinia spergulae, D.C.

Teleutospores. Sori on the under surface of the leaves, or on the stem, scattered or clustered, convex, circular or elongated, reddish-brown, then blackish ; spores spindle-shaped or club-shaped, tip rather pointed or roundish, much thickened, slightly constricted at the septum, narrowed towards the base, smooth, pale brown, 36—60 × 15—20 μ, pedicel colourless, persistent.

Syn. *Puccinia arenaria,* Plowr.; *Ured.*, p. 210 (in part).
Puccinia caryophyllarum, var. *spergulae,* West.

On leaves, leafstalks, and stem of *Spergula arvensis* and *Spergularia rubra.* Britain and Europe generally.

POLYGONACEAE

OXYRIA

Puccinia oxyriae, Fckl.; Plowr., *Ured.*, p. 194.

Uredospores. Sori scattered or in minute clusters circular or irregular in form, surrounded by the split epidermis, cinnamon, on minute purplish spots on both sides of the leaf, most abundant on the upper surface ;

spores subglobose or ovate, very minutely echinulate, yellowish-brown, 25—35 × 20—30 μ.

Teleutospores. Sori on both sides of the leaf, also frequently on the leafstalks, circular or irregular, sori elongated on the leafstalks and flower stems on discoloured spots; spores elliptical or oblong, tip rounded and slightly thickened, constricted at the septum, base generally rounded, very minutely warted, brown, 35—50 × 20—30 μ, pedicel colourless, rather long.

Syn. *Puccinia buchanani*, De Toni.

On *Oxyria reniformis*. Britain, Germany, Switzerland, Norway, Iceland, N. America.

POLYGONUM

Puccinia polygoni-amphibii, Pers.

Uredospores. Sori irregularly scattered, or often in circular groups, circular, soon naked and powdery, ochraceous, then brownish, on the under surface of the leaves; spores globose, elliptical or ovoid, echinulate, yellowish-brown, 20—30 × 15—25 μ.

Teleutospores. Sori on the under surface of the leaf, scattered or in circular clusters, sometimes scattered over the entire surface of the leaf, crowded, circular or elliptical, groups elongated on the stem, sometimes soon naked, at other times for some time covered by the epidermis, dusky brown; spores club-shaped or oblong, tip much thickened, rounded, somewhat pointed or truncate, scarcely constricted at the septum, base generally narrowed, smooth, chestnut-brown, 40—60 × 18—30 μ, pedicel persistent, rather thick, as long as the spore, colourless or tinged brown.

Syn. *Uredo polygonorum*, D.C.
Puccinia amphibii, Fuckel.
Puccinia polygoni, Pers.; Plowr., *Ured.*, p. 188.
Puccinia polygonorum, Link.
Trichobasis polygonorum, Berk.

On *Polygonum amphibium*, *P. convolvulus*, *P. Lapathifolium*, and *P. persicaria*. Britain, Europe, Africa, India, China, Japan, N. and S. America.

Puccinia bistortae, D.C.; Plowr., *Ured.*, p. 192.

Uredospores. Sori scattered or somewhat clustered, minute, circular, powdery, ochraceous, on the under surface of the leaf; spores globose or elliptical, very minutely echinulate, yellow, 25—30 × 18—22 μ.

Teleutospores. Sori scattered or more or less in small

clusters, often running into each other, very minute, circular, soon naked and powdery, dusky brown, on pale spots on the under surface of the leaf ; spores elliptical, ovate or oblong, tip broadly rounded, not thickened, base rounded or very slightly narrowed, smooth or very minutely punctate, brown, 30—40 × 18—25 μ, pedicel colourless, short, deciduous.

On *Polygonum viviparum* and *P. bistorta*. Britain, Europe, Korea, and N. America.

Puccinia acetosae, Kœrn.

Uredospores. Sori on both sides of the leaf, most frequently on the upper surface, sometimes on the stem, scattered, minute, circular, powdery, rusty brown ; spores globose, elliptical or pear-shaped, echinulate, brownish, 24—40 × 20—25 μ.

Teleutospores. Sori resembling those of the uredospores, minute, circular, or elongated on the stem, dusky brown ; spores ovoid, elliptical, oblong or somewhat club-shaped, ends rounded, or very slightly narrowed at the base, tip scarcely thickened, slightly constricted at the septum, very minutely warted, chestnut-brown, 30—50 × 20—30 μ, pedicel colourless, slender, deciduous.

On *Rumex acetosa* and *R. acetosella*. Britain, Europe generally, Siberia and N. America.

ARISTOLOCHIACEAE

ASARUM

Puccinia asarina, Kunze, Plowr., *Ured.*, p. 202.

Teleutospores. Sori present on both surfaces of the leaf, arranged in circular clusters, often crowded, on large yellowish-brown spots, often in circles, minute, surrounded by the torn epidermis, blackish ; spores oblong, ovate or somewhtat spindle-shaped, tip more or less conical, thickened, paler, slightly constricted at the septum, narrowed towards the base, smooth, yellowish-brown, 36—50 × 15—25 μ, pedicel, colourless, deciduous.

On *Asarum europaeum*. Britain, Europe generally, and N. America.

SANTALACEAE

THESIUM

Puccinia thesii, Chaill. ; Plowr., *Ured.*, p. 145.

Pycnidia. On both sides of the leaf, numerous, mixed with the aecidia.

Aecidia. On both sides of the leaves, usually sparingly scattered over the entire surface, rarely in circular or oblong groups, somewhat cylindrical cup-shaped, edge recurved, torn, whitish; spores angularly globose, very minutely warted, orange, 16—24 μ diam.

Uredospores. Sori on both surfaces of the leaf, and on the stem, irregularly distributed, minute, circular, for a long time covered by the epidermis, brown; spores subglobose or broadly elliptical, minutely warted, yellowish-brown, 20—30 μ diam.

Teleutospores. On both surfaces of the leaf, and on the stem, irregularly scattered, mostly minute, circular or elongated, rather compact, blackish; spores oblong, elliptic-oblong or oblong club-shaped, tip generally rounded, and much thickened, base rounded or narrowed, smooth, brown, 35—54 × 16—24 μ, pedicel tinged brown, thick, somewhat persistent, rather long.

Syn. *Aecidium thesii,* Desv.
Uredo thesii, Duby.

On leaves and stem of *Thesium humifusum.* Britain, Europe generally, and Siberia.

IRIDACEAE

IRIS

Puccinia iridis, Wallr.; Plowr., *Ured.*, p. 189.

Uredospores. Sori on both sides of the leaf, most abundant on the under surface, scattered, or in lax clusters, circular or elongated, for a long time covered by the epidermis, at length powdery, minute, rusty brown; spores globose, elliptical or ovate, echinulate, ochraceous, 20—35 × 16—26 μ, epispore thick.

Teleutospores. Sori on the under surface of the leaf, irregularly scattered, or sometimes in clusters, forming lines, soon naked, blackish; spores club-shaped or oblong, tip rounded and much thickened, sometimes pointed or truncate, darker, slightly constricted at the septum, base usually narrowed, smooth, pale brown, 30—52 × 15—25 μ, pedicel tinged brown, persistent, about as long as the spore.

Syn. *Uredo iridis,* D.C.; Berk.
Uredo iridis, Plowr.
Trichobasis iridis, Cooke.
Puccinia truncata, B. and Br.

On *Iris pseudacorus, I. foetidissima,* and on various cultivated species of *Iris.* Britain, Europe generally, Siberia, China, Japan, and N. America.

AMARYLLIDACEAE

NARCISSUS

Puccinia schroeteri, Passer.

Teleutospores. Sori on both surfaces of the leaves, scattered or sometimes in lax groups, spots indistinct or absent, sometimes in rings round a central sorus, medium size, circular or oblong, for a long time covered, then surrounded by the lead-coloured epidermis, dusky brown; spores broadly elliptical or elliptic-oblong, ends broadly rounded, tip not thickened, only very slightly constricted at the septum, indistinctly netted, by the running together of chains of minute warts, yellow, then chestnut colour, 38—60 × 24—36 μ, pedicel short, colourless.

On *Narcissus poeticus.* Britain, Italy, and Belgium.

LILIACEAE

ALLIUM

Puccinia porri, Winter; Plowr., *Ured.*, p. 148.

Aecidia. Sori on both sides of the leaf, on pale spots, in circles or roundish clusters, or in elongated clusters, shortly cylindrical, edge recurved, torn, white; spores polygonal, minutely warted, orange, 19—28 μ diam.

Uredospores. Sori on both sides of the leaves, generally on vague, pale spots, scattered, or often forming lines, minute, convex, and covered by the cracked epidermis at first, yellow or yellowish-brown; spores subglobose or elliptical, very delicately echinulate, yellow, 20—30 μ, diam.

Teleutospores. Sori on both surfaces of the leaves, spots generally absent, scattered, minute, circular or oblong, for a long time covered by the lead-coloured epidermis, dusky brown; spores oblong, tip rounded or slightly truncate, scarcely thickened, slightly constricted at the septum, base rounded or narrowed, smooth, brown, 28—45 × 20—26 μ, pedicel colourless, short, deciduous, mesospores numerous, obovate or pear-shaped, very irregular in shape, 22—36 15—23 μ.

Syn. *Uredo alliorum,* D.C.
Uromyces alliorum, Cooke (who mistook the mesospores for those of a *Uromyces*).

On leaves and scapes of *Allium schoenoprasum, A. ampeloprasum,* and *A. cepa.* Britain, Europe, and Syria.

ASPARAGUS

Puccinia asparagi, D.C.; Plowr., *Ured.*, p. 144.

Pycnidia. Honey-colour.

Aecidia On the stem, scattered, or sometimes in long clusters, remaining for a long time closed, then shortly cup-shaped, edge erect, white, torn ; spores angularly globose, very minutely warted, orange, 15—28 μ diam.

Uredospores. Sori oblong, narrow, for a long time covered by the epidermis, cinnamon-brown ; spores globose or elliptical, minutely echinulate, pale brown, 20—30 × 17—25 μ.

Teleutospores. Sori elliptical, oblong or linear, scattered or collected in groups, often forming extended crusts on the stem, rarely on the leaves, dusky brown ; spores elliptical or oblong, tip rounded and very much thickened, scarcely constricted at the septum, base rounded, smooth, chestnut-brown, 35—52 × 17—26 μ, pedicel persistent, colourless or tinged brown, as long or longer than the spore.

On *Asparagus officinalis.* Britain, Europe generally, Abyssinia and N. America.

This parasite often proves very destructive to cultivated Asparagus.

ORNITHOGALUM

Puccinia liliacearum, Duby; Plowr., *Ured.*, p. 197.

Pycnidia. Numerous, especially near the tips of the leaves, yellowish honey-colour.

Aecidia. Generally scattered, minute, deeply immersed in the substance of the leaf, the edge scarcely protruding, whitish ; spores angularly globose, or rarely elliptical, minutely warted, orange, 16—23 × 14—17 μ.

Teleutospores. Sori often on the dry, yellow parts of the leaves, generally densely crowded, often growing into each other, for some time covered by the grey eipdermis, then naked and powdery, reddish-brown ; spores oblong, tip not thickened, rounded or narrowed, scarcely constricted at the septum, base narrowed, smooth, pale brown, 40—75 × 25—35 μ, pedicel stout, colourless, rather long.

On living and faded leaves of *Ornithogalum umbellatum.* Britain and Europe generally.

TULIPA

Puccinia prostii, Mong.

Teleutospores. Sori on both surfaces of the leaf, spots none, scattered or in clusters, oblong, for a long time covered

by the epidermis, at length showing through the cracked epidermis, dusky brown; spores elliptical, ends rounded, scarcely constricted at the septum, dusky brown, covered with rather long, sharp, colourless spines, 54—66 × 34—40 μ, pedicel almost absent.

On leaves of cultivated tulips. Sent for identification from *Gard. Chron.*

JUNCACEAE

LUZULA

Puccinia obscura, Schroet.; Plowr., *Ured.*, p. 174.

Aecidia. On both sides of the leaves, on circular or irregularly shaped, discoloured spots, in loose clusters, or scattered without order, cylindric cup-shaped, edge whitish, torn; spores angularly globose, very minutely warted, yellowish, 16—22 μ diam.

Uredospores. Sori generally on the upper surface of the leaves, more or less crowded on irregularly shaped, brownish spots, elliptical or narrow, for a long time covered by the epidermis, then powdery, rusty yellow; spores globose, elliptical or ovate, echinulate, pale brown, 18—26 × 15—22 μ.

Teleutospores. Sori on the under surface of the leaf, on irregularly shaped, crowded, brown spots, generally scattered, oblong or narrow, surrounded by the split epidermis, soon naked, rather compact, dusky brown; spores oblong, tip rounded, rarely truncate or narrowed, thickened, slightly constricted at the septum, base usually narrowed, smooth, brown, 30—48 × 16—25 μ, pedicel almost colourless, persistent, up to 30 μ long; mesospores are often intermixed.

The aecidia occur on *Bellis perennis*.

The uredospores and teleutospores on *Luzula campestris*, *L. pilosa*, and *L. silvatica*. Britain, Europe generally, and N. America.

Puccinia oblongata, Winter; Plowr., *Ured.*, p. 190.

Uredospores. Sori on both surfaces of the leaves, on clustered, irregularly shaped, reddish-brown spots, scattered, circular or oblong, for a long time covered by the epidermis, rust-coloured; spores oblong-ovate, pear-shaped or club-shaped, rarely elliptical, smooth, or the tip sometimes minutely echinulate, yellow, 30—44 × 15—20 μ.

Teleutospores. Sori on both surfaces of the leaf, on irregularly shaped, brownish spots, which are more or less in clusters, scattered or in loose clusters, circular, oblong or long and narrow, surrounded by the split epidermis, rather

compact, dusky ; spores club-shaped, tip much thickened, rounded, or more or less narrowed, slightly constricted at the septum, base narrowed, smooth, brown, 45—80 × 18—28 μ, pedicel colourless, persistent, about as long as the spore.

Syn. *Uredo oblongata*, Grev.

On *Luzula campestris*, *L. pilosa*, and *L. maxima*. Britain, and Europe generally.

CYPERACEAE

CAREX

Puccinia caricis, Rebent.; Plowr., *Ured.*, p. 169.

Pycnidia. In minute clusters, honey-colour.

Aecidia. On the under surface of the leaves, or on the stem, on yellowish-brown or reddish-purple spots, which are often elongated and large, on the stem, and often causing distortion of the stem and leafstalks, cup-shaped, edge recurved, torn, white ; spores angularly globose, warted, orange, 16—26 × 15—20 μ.

Uredospores. Sori on both sides of the leaves, generally most abundant on the under surface, scattered, minute, oblong, pale brown ; spores subglobose or ovate, echinulate, yellowish-brown, 20—30 × 15—22 μ.

Teleutospores. Sori generally on the under surface of the leaf, scattered or arranged in lines, oblong or narrow and crowded into long, compact streaks, convex, blackish ; spores club-shaped, tip generally rounded, much thickened and darker, constricted at the septum, base narrowed, smooth, brown, 35—66 × 14—23 μ, pedicel tinged yellow, firm, about equal in length to the spore.

Syn. *Puccinia caricina*, Grev.
Puccinia striola, Link.
Uredo caricis, Berk.
Trichobasis carcina, Berk.

The aecidia occur on *Urtica dioicaea*, *U. urens*, and *U. pilulifera*.

The uredospores and teleutospores are parasitic on *Carex acuta*, *C. ampullacea*, *C. filiformis*, *C. glauca*, *C. praecox*, *C. hirta*, *C. riparia*, *C. paludosa*, *C. goodenoughii*, and *C. binervis*. Britain, Europe, Japan, N. and S. America.

Puccinia dioicae, P. Magn., Plowr., *Ured.*, p. 173.

Pycnidia. Arranged in small, honey-coloured groups.

Aecidia. On the under surface of the leaves, spots somewhat circular, yellowish or brownish in clusters, cup-

shaped, edge white, torn; spores angularly globose, minutely warted, orange, 18—25 μ diam.

Uredospores Sori, scattered, minute, brown; spores subglobose or elliptical, echinulate, pale brown, 25—28 μ.

Teleutospores. Sori scattered, circular or oblong, covered by the split epidermis, convex, blackish; spores club-shaped, tip rounded or narrowed, much thickened, slightly constricted at the septum, base narrowed, smooth, brown, tip darker, 35—56 × 18—24 μ, pedicel firm, tinged brown.

Aecidia on *Carduus palustris.*

Uredospores and teleutospores on *Carex dioica*, *C. davalliana* and *C. alba.*

Puccinia schoeleriana, Plowr. and Magn.; Plowr., *Ured.*, p. 171.

Pycnidia. On the upper surface of the leaf, orange.

Aecidia. On the under surface of the leaf, on large, yellowish or brownish-yellow spots, cup-shaped, edge whitish, torn; spores globose or angularly globose, very delicately echinulate, orange, 15—20 μ diam.

Uredospores. Sori most frequently on the under surface of the leaf, on yellow spots, minute scattered, circular or oblong, powdery, surrounded by the ruptured epidermis, pale brown, 24—30 × 18—25 μ.

Teleutospores. On the under surface of the leaf, scattered, or here and there, in clusters, minute, oblong, surrounded by the split epidermis, blackish; spores club-shaped or spindle-shaped, tip rounded or conical, much thickened, slightly constricted at the septum, base narrowed, smooth, brown, tip darkest, 50—80 × 18—25 μ, pedicel tinged brown, persistent.

Syn. *Aecidium jacobaeae,* Grev.
Aecidium compositarum, Mart.

Aecidia on Ragwort—*Senecia jvcobaea*

Uredospores and teleutospores on *Carex arenaria.* Britain, Germany, Holland, Russia,

Puccinia arenariicola, Plowr., *Ured.*, p. 170.

Aecidia. Edge prominent, torn, whitish, on yellow spots with a purple edge, mostly on the upper surface of the leaves, spots circular on the leaves, elongated on the stems; spores subglobose or polygonal, nearly smooth, yellow, 15—20 μ diam.

Uredospores. Sori linear or oblong and bursting through, brown, surrounded by the torn epidermis, seated on yel-

lowish spots; spores globose or ovate, finely echinulate, brown, 18—20 μ diam.

Teleutospores. Sori mostly on the under surface of the leaves, small, black, naked, persistent, linear or elongated; spores smooth, dark brown, oblong or wedge-shaped, the upper cell usually darker, rounded and thickened at the tip, lower cell somewhat narrowed below, slightly constricted at the septum, 40—50 × 20 μ, pedicel long, persistent.

Aecidia on *Centaurea nigra.*

Uredospores and teleutospores on *Carex arenaria.*

Puccinia extensicola, Plowr., *Ured.*, p. 181.

Aecidia. On pale spots, which are more or less circular on the leaves, and elongated on the stem, in rings or scattered, often on both surfaces, edge torn, white; spores globose, very finely echinulate, orange-yellow, 20—25 μ diam.

Uredospores. Sori minute, elliptical or linear, reddish-brown, on rather large pale spots; spores subglobose or ovoid, rather irregular, very finely echinulate, brownish-yellow, 25—30 × 15—20 μ.

Teleutospores. Sori small, elongated, black, surrounded by the torn epidermis; spores ovate or somewhat club-shaped, tip thickened, rounded or pointed, narrowed below, slightly constricted at the septum, smooth, brown, 40—60 × 18—20 μ, pedicel short, persistent.

Aecidia on *Aster tripolium.*

Uredospores and teleutospores on *Carex extensa.* Britain, Istria.

Puccinia paludosa, Plowr., *Ured.*, p. 174.

Aecidia. Irregularly clustered on the leaves, leafstalks, stem, and sometimes on the involucre, only slightly protruding, edge white, torn; spores subglobose, echinulate, orange, 15—28 × 10—16 μ.

Uredospores. Sori small, oval or elongated, soon naked and powdery, pale brown, on yellowish spots; spores globose, rarely oval, brown, with small pointed warts, which are scattered, 20—25 μ diam.

Teleutospores. Sori small, oval or elongated, rarely roundish, often in long, narrow lines, naked, black; spores, upper cell rounded and thickened above, often obliquely, lower cell subcylindrical, or wedge-shaped, rather deeply constricted at the septum, smooth, dark brown, 50—60 × 18—20 μ, pedicel rather long, brownish, persistent.

Syn. *Aecidium pedicularis*, Libosch.

Aecidia on *Pedicularis palustris* and *P. silvatica*.

Uredospores and teleutospores on *Carex vulgaris*, *C. stricta*, *C. fulva*—*C. panicea* ?

Britain, Germany, Austria, Hungary, Belgium, Russia, and Finland.

Puccinia uliginosa, Juel.

Aecidia. On the under surface of the leaf, on yellow, then brownish spots, or sometimes covering the under surface of the leaf, cup-shaped, edge recurved, torn, yellowish-white ; spores angularly globose, minutely echinulate, orange, 14—18 μ diam.

Uredospores. Sori on both surfaces of the leaves, scattered, very minute, circular or oblong, powdery, yellowish-brown ; spores subglobose or ovate, echinulate, brownish, 21—25 μ diam.

Teleutospores. Sori on both surfaces of the leaf, scattered, or here and there in clusters, minute, circular or oblong, convex, blackish ; spores oblong or oblong club-shaped, tip rounded and thickened, slightly constricted at the septum, base rounded or narrowed, smooth, brown, tip darkest, 35—40 × 15—20 μ, pedicel almost colourless, firm, up to 30 μ long.

Syn. *Aecidium parnassiae*, Groves. ; Cooke in Grev., I., p. 8, II, p. 161, Rabh.

Aecidium bifrons, D.C., var. *parnassiae*, Wallr.

Aecidia on leaves of *Parnassia palustris*.

Uredospores and teleutospores on *Carex vulgaris*.

SCIRPUS

Puccinia scirpi, D.C. ; Plowr., *Ured.*, p. 191.

Pycnidia. On the upper surface of the group, in circular groups.

Aecidia. On the upper surface of the leaves, on large, more or less circular yellowish spots, cup-shaped, yellowish edge irregularly torn ; spores angularly globose, very minutely warted, orange, 12—20 μ diam.

Uredospores. Sori scattered or in lines, often crowding into each other, oblong, elliptic, or long and narrow, for some time covered by the inflated epidermis, rusty ; spores subglobose, elliptical or ovoid, echinulate, pale brown, 19—32 × 12—24 μ.

Teleutospores. Sori resembling those of the uredospores, generally numerous and crowded into each other, dusky

brown; spores oblong or somewhat club-shaped. tip rounded, truncate or narrowed, thickened, scarcely constricted at the septum, base narrowed into the pedicel, smooth, brown, 30—60 × 12—24 μ, pedicel, tinged yellow, persistent; mesospores more or less frequently present, and intermixed, 24—40 μ long, smooth.

Syn. *Uredo scirpi*, West.
Puccinia typhae, Kalchbr.
Aecidium nymphoides, D.C.

The aecidia occur on *Limnanthemum nymphoides*.

The uredospores and teleutospores on *Scirpus lacustris* and *S. tabernaemontana*. Britain and Europe generally.

GRAMINACEAE

Puccinia graminis, Pers.; Plowr., *Ured.*, p. 162.

Pycnidia. Arranged in small clusters, honey-colour.

Aecidia. On the under surface of the leaves, also often on the fruit, on thickened, purplish spots, with a yellow border, cylindrical and somewhat erect, whitish, edge torn; spores angularly globose, almost or quite smooth, orange, 18—30 μ diam.

Uredospores. Sori on both surfaces of the leaf, also on the leafsheaths and culm, scattered or arranged in rows, elongated, narrow, 2—3 mm. long, often growing into each other end on, and forming long streaks, surrounded by the split epidermis, powdery, yellowish-brown; spores generally elliptical, or ovate-oblong, echinulate, yellowish-brown, 25—45 × 18—25 μ, with usually four germ-pores, arranged equatorially.

Teleutospores. Sori on both surfaces of the leaf, also commonly on the leafsheaths and culm, scattered or arranged in rows, often running into each other end on, and forming long streaks, soon naked, powdery, blackish; spores oblong club-shaped or club-shaped, tip rounded or narrowed, much thickened, very slightly constricted at the septum, base narrowed, smooth, chestnut-brown, 40—60 × 15–25 μ, pedicel tinged brown, persistent, thick, up to 60 μ long; paraphyses absent.

Syn. *Aecidium berberidis*, Pers.
Uredo frumenti, Sow.
Uredo linearis, Pers.
Trichobasis linearis, Lév.
Puccinia poculiformis, West.
Puccinia graminis, Pers.

The aecidia occur on the barberry—*Berberis vulgaris* and *Mahonia ilicifolia* in this country, also on many other species of *Berberis* and *Mahonia* elsewhere.

The uredospores and teleutospores occur on species of *Agrostis, Agropyrum, Aira, Alopecurus, Arrhenatherum, Avena, Brachypodium, Briza, Bromus, Calamogrostis, Cynodon, Dactylus, Elymus, Festuca, Holcus, Hordeum, Milium, Lolium, Molinia, Koeleria, Panicum, Poa, Phleum, Secale, Triticum,* and other genera of grasses.

This fungus constitutes the dreaded "rust" of wheat, which does injury to the amount of several millions of pounds sterling annually, throughout the world. Eriksson has shown that several forms of this species have become what are termed "biologic species," that is, they can only infect certain species of host-plants.

Britain, Europe, Africa, Asia, Australia, N. and S. America.

Puccinia coronata, Corda; Plowr., *Ured.*, p. 163 (in part).

Aecidia. On the under surface of the leaf, or on the leafstalks, on yellow or purplish-yellow spots, rounded or irregularly scattered, distorting the leaves and more especially the leafstalks, cylindrical, edge recurved, torn, white; spores angularly globose, very delicately warted, orange, 15—25 × 14—20 μ.

Uredospores. Sori on the under surface of the leaves, scattered or in lines, often growing into each other, minute, more or less oblong, powdery, orange; spores globose, subglobose or ovate, echinulate, yellow, 20—30 × 16—24 μ, with three or four germ-pores; a few paraphyses are intermixed.

Teleutospores. Sori on the under surface of the leaf, generally irregularly scattered, sometimes clustered, oblong or narrow, for a long time covered by the epidermis, then naked, black; spores club-shaped, tip flat and bearing small outgrowths or blunt spines, not at all, or very slightly constricted at the septum, base narrowed, smooth, brown, 35—60 × 18—25 μ, pedicel short, rather thick.

Syn. *Aecidium crassum,* Pers.
Aecidium rhamni, Gmel.
Aecidium frangulae, Schum.
Uredo coronata, Erikss. and Henn.

Aecidia on *Rhamnus frangulae.*

Uredospores and teleutospores on *Agrostis alba, A. stolonifera, A. vulgaris, Calamagrostis arundinacea, Holcus mollis, H. lanatus, Phalaris arundinacea, Triticum repens.*

Puccinia lolii was mixed up with the present species by Plowright.

Britain, Europe, Asia, Australia, N. America.

Puccinia lolii, Niels.

Aecidia. On the under surface of the leaves and on the leafstalks, on yellow or purplish-yellow spots, causing distortion of the leaves, and more especially the leafstalks, cylindrical, edge recurved, white, torn; spores angularly globose, very minutely warted, orange, 16—25 × 12—20 μ.

Uredospores. Sori on the under surface of the leaves, scattered or in lines, sometimes crowded, minute, more or less oblong, powdery, orange; spores globose, subglobose or ovate, echinulate, yellow, 20—30 × 16—24 μ, with three or four germ-pores; a few paraphyses are sometimes present.

Teleutospores. Sori on the under surface of the leaf, often surrounding the uredospore sori in rings, rarely scattered, sometimes crowded, oblong or narrow, covered for a long time, or permanently, by the epidermis, blackish, spores club-shaped, tip flattened and crowded with sharp, dark coloured outgrowths or teeth, not at all, or very slightly constricted at the septum, base narrowed, smooth, brown, 35—60 × 12—22 μ, pedicel short, thickish.

Aecidia on leaves and leafstalks of *Rhamnus catharticus.*

Uredospores and teleutospores on *Alopecurus pratensis, Avena fatua, A. sativa, Festuca elatior, Glyceria aquatica, Holcus mollis, H. lanatus, Lolium perenne.*

Britain, Europe, Asia, Australia, and N. America.

Puccinia glumarum, Erikss. and Henn.

Uredospores. Sori on the under surface of the leaves, minute, oblong, in lines, sometimes crowded, pale yellow; spores globose, subglobose or broadly elliptical, echinulate, yellow, 25—30 × 18—26 μ.

Teleutospores. Sori on the under surface of the leaves, or on the culm, forming long lines, often scattered on the glumes, oblong, dusky or blackish, covered by the epidermis; spores club-shaped, tip rounded, truncate or narrowed, thickened, slightly constricted at the septum, base narrowed, smooth, brown, 30—70 × 12—24 μ, pedicel almost absent; paraphyses numerous, brown.

Syn. *Puccinia tritici,* Oerst.
Puccinia neglecta, West.
Puccinia rubigo-vera. Many authors in part.

Trichobasis glumarum, Lév.

On leaves, culms and spikes of *Brachypodium silvaticum*, *Bromus mollis*, *Calamagrostis epigaea*, *Elymus arenarius*, *Hordeum vulgaris*, *Secale cereale*, *Triticum caninum*, *T. repens*, *T. vulgaris*. Britain, Europe, Egypt, Japan, and N. America.

Puccinia dispersa, Erikss. and Henn.

Aecidia. On the under surface of the leaves, also on the calyx and fruit, on yellow or reddish-yellow spots, cup-shaped, edge recurved, torn; spores subglobose, minutely warted, orange, 20—26 μ diam.

Uredospores. Sori generally on the upper surface of the leaves, scattered without order, small, oblong, rusty; spores globose or subglobose, echinulate, yellow, 22—28 μ diam.

Teleutospores. Sori on the under surface of the leaves or on the leafsheaths, scattered, or sometimes clustered, oblong, covered by the epidermis, blackish; spores oblong club-shaped or club-shaped, tip rounded or obliquely narrowed, slightly thickened, generally slightly constricted at the septum, base narrowed, smooth, brown, 40—50 × 12—20 μ, pedicel short; paraphyses numerous, brownish.

Syn. *Aecidium asperifolii*, Pers.
Uredo rubigo-vera, D.C.
Puccinia straminis, Fuckel.
Puccinia rubigo-vera, Winter; Plowr., *Ured.*, p. 167 (in part).

The aecidia occur on the leaves, calyx and fruit of *Anchusa arvensis*.

Uredospores and teleutospores on rye—*Secale cereale*. Britain, Europe generally, Asia Minor, and N. America.

Puccinia bromina, Eriksson.

Pycnidia. Honey-colour.

Aecidia. On the under surface of the leaves, or on the leafstalks, sometimes also on the calyx, on large, brownish or purplish spots, often with a yellowish border, cup-shaped, edge recurved, torn; spores angularly globose, minutely warted, orange, 18—27 μ diam.

Uredospores. Sori on both surfaces of the leaf, most abundant on the upper side, scattered or in clusters, oblong, sometimes crowded into each other, rusty; spores globose, subglobose or broadly elliptical, echinulate, yellow, 20—26 μ diam.

Teleutospores. Sori on the under surface of the leaf, scattered, minute, oblong, covered by the epidermis,

blackish ; spores oblong club-shaped or club-shaped, tip rounded, sometimes obliquely narrowed, not at all, or only very slightly thickened, generally slightly constricted at the septum, base generally narrowed, smooth, brown, 30– 50 × 14 18 μ, pedicel short ; paraphyses numerous, brown.

Syn. *Aecidium asperifolii*, Pers. (in part).

Uredo bromina, Eriksson.

Aecidia are developed on the leaves, leafstalks, and sepals of *Symphytum officinale*.

Uredospores and teleutospores on *Bromus arvensis*, *B. asper*, *B. sterilis*, *B. maximus*, and other species of *Bromus*. Britain, Europe generally, and Asia Minor.

Puccinia triticina, Erikss.

Uredospores. Sori on both surfaces of the leaves, most frequent on the upper surface, scattered, oblong, medium size, rusty ; spores subglobose, echinulate, yellow, 20- 27 μ diam.

Teleutospores. On the under surface of the leaves, and on the culms, scattered, or often in rows on the culm, oblong, covered by the epidermis, blackish ; spores club-shaped or oblong club-shaped, tip rounded or obliquely narrowed, scarcely thickened, slightly constricted at the septum, base narrowed, smooth, brown, 30– 45 × 12– 20 μ, pedicel short ; paraphyses numerous, brownish.

Syn. *Uredo triticina*, Eriksson.

Occurring on the leaves and culms of *Triticum vulgaris* and *T. spelta*.

Britain, Europe generally, and N. America.

AGROSTIS

Puccinia agrostidis, Plowr.

Pycnidia. Honey-coloured, on roundish spots.

Aecidia. Sori on the under surface of the leaves, on circular or irregular, yellowish spots that often have a brownish border, or in oblong, inflated patches, shortly cylindrical, edge white, torn ; spores angularly globose, very delicately warted, 16—30 × 14—20 μ.

Uredospores. Sori on both surfaces of the leaves, on elongated, narrow, yellowish spots, bright orange ; spores subglobose or ovate, yellow, minutely echinulate, 21- 25 × 16—22 μ.

Teleutospores. Sori on the under surface of the leaf, minute, oblong or narrow, sometimes crowded, covered by the epidermis, blackish ; spores more or less club-shaped,

tip rounded, abrupt, or somewhat pointed, slightly thickened, scarcely constricted at the septum, base narrowed, smooth, brown, tip darkest, 35—50 × 15—24 μ, pedicel very short.

Syn. *Aecidium aquilegiae*, Pers.
Puccinia aquilegiae, Lagerh.

The aecidia occur on the leaves of various cultivated species of *Aquilegia, A. alpina, A. atrata, A. glandulosa, A. haenkeana, A. nigricantis, A. pyreniaca, A. sternbergii.*

The uredospores and teleutospores on *Agrostis alba* and *A. vulgaris*. Britain, Europe, India.

Puccinia perplexans, Plowr.

Aecidia. On the under surface of the leaves and on the leafstalks, on yellowish circular or elongated spots, cylindric cup-shaped, edge white, torn ; spores angularly globose minutely warted, orange, 18—27 μ diam.

Uredospores. Sori on both surfaces of the leaves, scattered, circular, oblong or narrow, sometimes crowded, minute, yellowish-brown ; spores subglobose or ovate, minutely echinulate, yellow, 20—28 μ diam.

Teleutospores. On both surfaces of the leaves, scattered, minute, sometimes crowded into each other, generally oblong or narrow, remaining covered by the epidermis, blackish ; spores variable in form, generally club-shaped or oblong club-shaped, tip rounded, truncate or rarely obliquely pointed, very slightly thickened, slightly constricted at the septum, base narrowed, smooth, brown, 36—56 × 18—24 μ, pedicel very short.

Syn. *Aecidium ranunculi-acris*, Pers.
Aecidium ranunculacearum, D.C. (in part).

Aecidia occur on the leaves and leafstalks of *Ranunculus acris.*

Uredospores and teleutospores on leaves of *Alopecurus pratensis.* Britain, Germany, Holland.

ANTHOXANTHUM

Puccinia anthoxanthi, Fckl. ; Plowr., *Ured.*, p. 194.

Uredospores. Sori on both surfaces of the leaves on yellowish, vague spots, scattered or clustered, elliptical or narrow, minute, soon naked, rusty yellow ; spores generally ovate, delicately echinulate, 20—30 × 15—20 μ.

Teleutospores. Sori on both surfaces of the leaves, scattered, minute, soon naked, elliptical or narrow, dusky brown ; spores elliptical, oblong, or somewhat clavate

tip generally rounded and thickened, slightly constricted at the septum, base rounded, rarely, narrowed, smooth chestnut-brown, 24—48 × 16—22 μ, pedicel tinged brown, persistent.

On living and fading leaves of *Anthoxanthum odoratum*. Britain and Belgium, Germany.

Plowright says the uredospores are usually mixed with a large number of capitate, colourless paraphyses.

ARRHENATHERUM

Puccinia arrhenatheri, Eriksson.

Pycnidia. Very numerous, covering the whole or a great portion of the leaf.

Aecidia. On the under surface of the leaves, sometimes also on the flowers, and shoots, which are distorted, generally covering the entire surface of the leaf, cylindric cup-shaped, edge recurved, whitish, torn; spores subglobose or elliptical, minutely warted, yellowish, 19—32 × 16—24 μ.

Uredospores. Sori most abundant on the upper surface of the leaves, rarely on the under surface, on minute yellow spots, elliptic or oblong, minute, pale rusty; spores subglobose or ovate, echinulate, yellow, 19—30 × 19—26 μ, with numerous germ-pores; paraphyses numerous, 80 × 10—14 μ.

Teleutospores. Sori on the under surface of the leaves, scattered, minute, circular or shortly elongated and narrow, covered by the epidermis, blackish; spores elliptic-oblong or oblong club-shaped, tip rounded, truncate or slightly narrowed, thickened and darker in colour, not at all or very slightly constricted at the septum, base generally narrowed, smooth, pale brown, 30—45 × 18—24 μ, pedicel short, tinged brown; paraphyses brownish.

Syn. *Puccinia perplexans*, Plowr., var. *arrhenatheri*, Klebahn.

P. magelhaenica, Peyr.

The aecidia occur on the leaves, flowers and shoots of the barberry—*Berberis vulgaris*.

Uredospores and teleutospores on living leaves of *Arrhenatharum elatior*. Britain, Germany, Austria, Hungary, Switzerland, Sweden, Finland, and Turkestan.

BRACHYPODIUM

Puccinia baryi, Winter; Plowr., *Ured.*, p. 191.

Uredospores. Sori minute, scattered or clustered, often arranged in lines, long, rust-coloured, on narrow, brownish

spots; spores subglobose or ovate, very minutely echinulate, yellow, 18—25 μ diam.

Teleutospores. Sori similar to those of the uredospores, for a long time covered by the epidermis, dusky brown; spores elliptical or somewhat club-shaped, tip slightly thickened, blunt or truncate, not at all or very slightly constricted at the septum, base rounded or narrowed into the pedicel, smooth, brown, 25—35 × 15—25 μ, pedicel very short or almost absent, tinged brown.

Syn. *Puccinia brachypodii*, Otth.

On living and fading leaves of *Brachypodium silvaticum* and *B. pinnatum*. Britain and Europe generally.

FESTUCA

Puccinia festucae, Plowr.

Pycnidia. Honey-coloured, arranged in small clusters.

Aecidia. On the under surface of the leaves, in groups on rather large, more or less circular, yellow or brownish spots, shortly cylindrical or cup-shaped, yellowish-white, edge recurved and irregularly torn; spores globose or angularly globose, minutely warted, orange, 16—27 μ diam.

Uredospores. Sori on the upper surface of the leaves, scattered, minute, oblong, yellow; spores subglobose or elliptical, echinulate, yellowish-brown, 22—30 μ diam.

Teleutospores. Sori on the under surface of the leaves, minute, scattered, oblong or narrow, dusky brown; spores cylindric club-shaped, with four to six incurved outgrowths at the tip, these outgrowths or spines are sometimes forked, slightly constricted at the septum, base narrowed, smooth, pale brown, 40—60 × 15—23 μ, pedicel brownish, persistent, short.

Syn. *Aecidium periclymeni*, Schum.; Plowr., *Ured.*, p. 264.

Aecidium crassum, var. *periclymeni*, Cooke.

The aecidia appear on living leaves of the honeysuckle—*Lonicera periclymenum*, and on other species of *Lonicera*.

The uredospores and teleutospores on *Festuca duriuscula*, *F. ovina*, and *F. rubra*.

Britain, Europe generally, and N. America.

KOELERIA

Puccinia paliformis, Fuckel; Plowr., *Ured.*, p. 203.

Teleutospores. Sori on the leaves and culm, scattered minute, circular or oblong, bounded by the ruptured epider-

mis, convex, dusky brown; spores club-shaped, tip generally truncate or slightly narrowed, much thickened, slightly constricted at the septum, base narrowed, smooth, pale brown, 40—56 × 10—22 μ, pedicel colourless, about equal in length to the spore.

On leaves and culms of *Koeleria cristata*.

MOLINIA

Puccinia moliniae, Tul.

Aecidia. On the under surface of the leaves on brownish or purplish spots, cup-shaped, edge recurved and torn, white; spores angularly globose, very minutely warted, yellowish, 15—18 μ diam.

Uredospores. Sori on both surfaces of the leaves, most frequently on the under surface, on brownish or purplish spots, scattered or in crowded lines, oblong or narrow, brown, spores subglobose, aculeate, yellowish-brown, 20—28 × 20—24 μ.

Teleutospores. Sori on both surfaces of the leaves, most abundant on the under surface, scattered or in clusters, oblong or narrow and elongated, convex, blackish; spores elliptical, ends rounded, tip thickened, not at all, or very slightly constricted at the septum, smooth, brown, 36—46 × 20—30 μ, pedicel colourless or tinged yellow, rather thick, long; a few mesospores sometimes intermixed.

Syn. *Puccinia nemoralis,* Juel.
Aecidium melampyri, Kze.

Aecidia on *Melampyrum arvense, M. cristatum,* and other species of *Melampyrum.*

Uredospores and teleutospores on *Molinia caerulea.*

The aecidial form of this species has, incorrectly, been described as occurring on *Orchis latifolia,* and on other orchids.

PHALARIS

Puccinia sessilis, Schneid.

Pycnidia. On the upper surface of the leaf.

Aecidia. On the under surface of the leaf, on circular or irregularly-shaped yellowish spots, cup-shaped, white, edge recurved and torn; spores angularly globose, minutely warted, yellowish, 19—27 μ diam.

Uredospores. Sori on both surfaces of the leaf, scattered, minute, dot-like or slightly elongated, yellow; spores globose, subglobose or elliptical, echinulate, yellowish-brown, 20—28 × 18—24 μ.

Teleutospores. Sori on both surfaces of the leaves, scattered, or sometimes crowded, minute circular or slightly elongated, for a long time covered by the epidermis, powdery, blackish ; spores oblong or oblong club-shaped, tip rounded or truncate, and slightly thickened, not at all, or very slightly constricted at the septum, base narrowed, smooth, brown, 35—52 × 15—22 μ, pedicel very short.

Syn. *Aecidium convallariae*, Schum.
Puccinia digraphidis, Soppitt.
Puccinia intermixta, H. Friend.
Puccinia linearis, Rob. ; Cooke (?).
Puccinia paridis, Plowr.

The aecidia occur on *Convallaria majalis*, *Maianthemum bifolium*, *Paris quadrifolia*.

The uredospores and teleutospores on the leaves of *Phalaris arundinacea*.

Britain, Europe generally, N. America, Japan (?).

Puccinia orchidearum-phalaridis, Klebahn.

Pycnidia. On the upper surface of the leaf.

Aecidia. On the under surface of the leaves, on roundish, yellowish spots, cup-shaped, whitish, edge reflexed and torn ; spores angularly globose or elliptical, minutely warted, yellowish, 17—26 μ diam.

Uredospores and *teleutospores*, as in *Puccinia sessilis*.

Syn. *Aecidium orchidearum*, Desm.

The aecidia occur on living leaves of *Orchis incarnata*, *O. latifolia*, *O. maculata*, *O. militaris*, *O. morio*, *Platanthera bifolia*, *P. chlorantha*, *Gymnadenia conopsea*, *Listera ovata*.

The uredospores and teleutospores on living leaves of *Phalaris arundinacea*. Britain and Europe generally.

Puccinia winteriana, P. Magnus.

Pycnidia. On the upper surface of the leaf.

Aecidia. On the under surface of the leaves, on rather large, roundish, yellowish spots, cup-shaped, white, edge recurved and torn ; spores angularly globose, very minutely warted, yellowish, 17—26 μ diam.

Uredospores and *teleutospores* as in *Puccinia sessilis*.

Syn. *Aecidium allii-ursini*, Pers.
Aecidium allii, Grev.
Puccinia sessilis, Schneid. ; Plowr., *Ured.*, p. 165.

The aecidia appear on the leaves of *Allium ursinum*.

The uredospores and teleutospores on the leaves of *Phalaris arundinacea*.

Britain, Germany, France, Switzerland, and Holland.

Puccinia phalaridis, Plowr.

Pycnidia. On the upper surface of the leaves.

Aecidia. On the under surface of the leaves, on more or less circular, yellowish spots, not very prominent, edge white, torn ; spores angularly globose, echinulate, yellowish, 15—26 μ diam.

Uredospores and *teleutospores* as in *Puccinia sessilis.*

Syn. *Puccinia ari-phalaridis,* Klebahn.
Puccinia ari, Lagerheim.

The aecidia appear on the living leaves of *Arum maculatum,* and perhaps on *Arum italicum.*

Uredospores and teleutospores on living leaves of *Phalaris arundinacea.*

Britain, Europe generally, and perhaps in N. America.

PHRAGMITES

Puccinia magnusiana, Koern. ; Plowr., *Ured.,* p. 177.

Aecidia. On the under surface of the leaf, on the leaf-stalks, and on the stem, on yellow, more or less circular spots, cup-shaped, whitish, edge torn ; spores subglobose, minutely warted, yellowish, 15—25 μ diam.

Uredospores. Sori on both surfaces of the leaves, usually scattered, minute or medium size, elliptical or oblong, powdery, pale yellowish-brown ; spores subglobose, ovate elliptical, minutely echinulate, yellowish-brown, 20—35 × 12—20 μ, germ-pores indistinct, paraphyses numerous, club-shaped, colourless or tinged brown.

Teleutospores. Sori on both surfaces of the leaves, scattered, or more or less crowded over the entire surface, minute or medium size, oblong or narrow, often forming long narrow streaks on the culm, compact, flat, blackish ; spores oblong or club-shaped, tip rounded or rarely narrowed or truncate, thickened, scarcely narrowed at the septum, base narrowed into the pedicel, smooth, brown, tip darker, 32—55 × 16—26 μ, pedicel thick, tinged brown, persistent, equal to or shorter than the spore.

Syn. *Puccinia graminis,* Pers., var. *arundinis,* Cooke.
Aecidium ranunculacearum, D.C.

The aecidia grow on the leaves, leafstalks, and stems of *Ranunculus bulbosus,* and *R. repens.*

The uredospores and teleutospores on the leaves of *Phragmites communis.*

Britain, Europe, S. Africa, and Japan.

Puccinia phragmitis, Koern. ; Plowr., *Ured.*, p. 175.

Aecidia. On the under surface of the leaves, on large brownish or purplish spots, shortly cylindrical cup-shaped, edge white, recurved, torn ; spores angularly globose, minutely warted, almost colourless, 16—26 μ diam.

Uredospores. Sori on both surfaces of the leaves, scattered or somewhat clustered, elliptical or narrow and elongated, rather large, convex, powdery, brown, no paraphyses present ; spores subglobose, ovate or elliptical, minutely warted or echinulate, brownish, 25—35 × 16—20 μ, epispore thickish, with four germ-pores arranged equatorially.

Teleutospores. Sori on both surfaces of the leaves, scattered or in clusters, elliptic, oblong or narrow, often growing into each other, large, convex, thick, dusky brown ; spores oblong, somewhat rounded at the ends, tip thickened, constricted at the septum, smooth, deep yellowish-brown, 45—65 × 16—25 μ, rarely up to 75 μ in length, pedicel tinged yellow, stout, persistent, 100—200 μ long.

Syn. *Puccinia arundinacea,* D.C.
Aecidium rubellum, Gmel.
Caeoma rumicis, Schlecht.

The aecidia occur on living leaves of *Rumex aquaticus, R. conglomeratus, R. crispus, R. hydrolapathum, R. maritimum, R. obtusifolium,* and on rhubarb—*Rheum officinale.*

Teleutospores and uredospores on *Phragmites communis,* and perhaps on *Arundo donax.*

Britain, Europe, S. Africa, Japan, N. and S. America.

Puccinia trailii, Plowr., *Ured.*, p. 175.

Aecidia. On the under surface of the leaf, on more or less circular, brownish or brownish-purple spots, cup-shaped, edge recurved, white, torn ; spores angularly globose, minutely warted, colourless, 16—27 μ diam.

Uredospores. Sori on both surfaces of the leaves, scattered, rather large, elliptical or narrow, reddish-brown, powdery ; paraphyses absent ; spores subglobose, ovate or elliptical, pale brown, 25—35 × 20—25 μ.

Teleutospores. Sori on both surfaces of the leaf, scattered, often running into each other, compact, convex, blackish ; spores oblong, ends somewhat rounded, thickened, constricted at the septum, brown, very minutely granulated, 50—60 × 20—23 μ, pedicel stout, firm, tinged brown, 75—100 μ long.

Syn. *Aecidium rubellum,* Gmel. (in part).

The aecidia are produced on living leaves of *Rumex acetosa*.

The uredospores and teleutospores on the leaves of *Phragmites communis*.

Britain, Germany, and Holland.

The uredospores and teleutospores are practically indistinguishable from those of *Puccinia phragmitis*, Koern., but the aecidial form is produced on *Rumex acetosa*, and not on any other species of *Rumex*, nor on *Ranunculus*.

Puccinia poarum, Neils. ; Plowr., *Ured.*, p. 168.

Pycnidia. On the upper surface of the leaves.

Aecidia. On the under surface of the leaves, on more or less circular, yellowish or brownish spots, cylindrical then expanding, edge recurved, toothed, white ; spores polygonal, minutely warted, orange, 18—25 × 16—20 μ.

Uredospores. Sori on the leaves, also frequently on the culm, minute, circular or elliptical, yellow ; spores globose, subglobose or elliptical, minutely echinulate, yellow, 17—28 × 17—25 μ, with numerous capitate paraphyses intermixed.

Teleutospores. Sori on the leaves and also frequently on the culm, scattered or here and there in clusters, minute, more or less circular, oblong or narrow, covered by the epidermis, blackish ; spores ovate-oblong on oblong club-shaped, variable in form, tip rounded, truncate or narrowed, slightly thickened and deeply coloured, very slightly or not at all constricted at the septum, base more or less narrowed, smooth, brown, 30—45 × 16—22 μ, pedicel short, tinged brown.

Syn. *Aecidium tussilaginis*, Gmel.
Aecidium compositarum, Mart.

The aecidia occur on living leaves of Coltsfoot—*Tussilago farfara*.

Uredospores and teleutospores on *Poa annua, P. alpina, P. compressa, P. trivialis, P. pratensis, P. nemoralis.*

Britain, Europe, Japan, and N. America.

TRITICUM

Puccinia agropyri, Ellis and Everh.

Aecidia. On the under surface of the leaves, on the leaf-stalks, and on the stem, spots generally yellowish-brown, with a darker border, spots rarely absent, shortly cylindrical, edge broadly recurved, torn ; spores subglobose or angular, minutely warted, 18—27 μ diam.

Uredospores. Sori on both surfaces of the leaves, most abundant on the under side, on irregularly shaped yellowish spots, scattered, oblong or narrow, cinnamon; spores subglobose, minutely echinulate, pale yellow, 19—27 μ diam.

Teleutospores. Sori on the upper surface of the leaves, scattered, or sometimes in clusters, oblong or often narrow, covered by the lead-coloured epidermis, blackish; spores cylindric-clavate, tip generally truncate, rarely rounded or somewhat narrowed, thickened, slightly or not at all constricted at the septum, base narrowed, smooth, pale brown, tip darker, 40—80 × 11—22 μ, pedicel short, almost colourless.

Syn. *Aecidium ranunculacearum*, D.C., var. *clematidis*, D.C.; Plowr., *Ured.*, p. 265.
Aecidium clematidis, Schwein.

The aecidia occur on *Clematis vitalba*, also on several other species of *Clematis*.

Uredospores and teleutospores on *Triticum* (*Agropyrum*) *glaucum*, and *T. junceum*.

Britain, Europe, Turkestan, Japan, N. and S. America.

Puccinia persistens, Plowr., *Ured.*, p. 180.

Pycnidia. Arranged in minute clusters, orange.

Aecidia. On the under surface of the leaves, spots purple-brown on the upper surface, yellow with a brownish border on the under surface, cup-shaped or more or less cylindrical, yellow, edge white, torn; spores angularly globose or elliptical, minutely warted, orange, 14—28 μ diam.

Uredospores. Sori minute, circular or elongated, on yellowish spots, orange; spores subglobose, minutely echinulate, yellow, 25—30 μ diam.

Teleutospores. Sori minute, ovate, oblong or narrow, for a long time covered by the epidermis; spores cylindrical or club-shaped, tip truncate, rounded or obliquely narrowed, slightly thickened, more or less constricted at the septum, base narrowed, smooth, brown, 50—60 × 15—20 μ, pedicel short, persistent, colourless.

Syn. *Aecidium ranunculacearum*, D.C., var. *thalictri*, Cooke.
Aecidium thalictri, Grev.

The aecidium stage occurs on the leaves of *Thalictrum flavum*, *T. minus*, and on other species of *Thalictrum*.

Uredospores and teleutospores on *Triticum repens*, and perhaps on *Arrhenatherum elatior* (=*Avena elatior*).

European species of Puccinia *parasitic on British plants, but not recorded as occurring in Britain.*

ARTEMISIA, L.

Puccinia artemisiella, Syd. .

Teleutospores. Sori small, scattered or clustered, mostly on the upper surface of the leaves, black, partly hidden by down; spores oblong or elliptic-oblong, tip generally rounded and thickened, constricted at the septum, smooth, pale chestnut, 35—49 × 14—21 μ, pedicel long, stout, tinged brown, persistent.

On living leaves of wormwood—*Artemisia vulgaris.* Germany.

CIRSIUM

Puccinia cirsii-lanceolati, Schroet.

Aecidia. Seated on minute yellow spots on the under surface of the leaf, for a long time closed, then opening by a small pore, whitish; spores subglobose, warted, orange, 22—35 × 20—28 μ.

Uredospores. Generally on the upper surface, rusty; spores subglobose, echinulate, brown, 24—36 × 20—26 μ.

Teleutospores. Generally on the upper surface, minute; spores elliptical, tip rounded, not thickened, punctate, dusky brown, 30—40 × 22—25 μ, pedicel short.

On leaves of *Cirsium lanceolatum* and *C. eriophorum.* Europe generally, and N. America.

Puccinia le mourieriana, Maire.

Teleutospores. Sori on under surface, on round or irregular spots; spores club-shaped, tip variable, much thickened, constricted, smooth, yellowish-brown, 40—55 × 14—21 μ, pedicel stout, persistent.

On *Cirsium palustris.* France, Spain.

CREPIS

Puccinia crepidis, Schroet.

Pycnidia. Scattered amongst the aecidia.

Aecidia. Often covering the under surface, edge white, spores minutely warted, tinged yellow, 15—25 × 14—20 μ.

Uredospores. Generally on the under surface; spores subglobose, pale brown, 20—25 × 16—20 μ.

Teleutospores. Mostly on the under surface, spores elliptical, not constricted, minutely punctate, chestnut, 20—30 × 17—22 μ, pedicel slender.

On *Crepis virens.* Europe generally.

CHRYSANTHEMUM

Puccinia leucanthemi, Pass.

Teleutospores. Sori on both sides, most frequent on the under surface, also on the petioles, scattered or in rings; spores oblong or somewhat club-shaped, tip much thickened, constricted, smooth, yellowish, 40—70 × 14—24 μ, pedicel stout.

On *Chrysanthemum leucanthemum.* Italy.

PLANTAGO

Puccinia plantaginis, West.

Teleutospores. Sori on both sides, minute; spores ovate or pear-shaped, tip rounded, not thickened, punctate, pale chestnut, 28—40 × 20—25 μ, pedicel short, fragile.

On *Plantago lanceolata.* Belgium.

VERONICA

Puccinia veronicae-anagallidis, Oud.

Teleutospores. On both surfaces of the leaves, minute, pale brown; spores elliptical, ends rounded, tip not thickened, not constricted, minutely warted, pale brown, 30—41 × 16—24 μ, pedicel short.

On *Veronica anagallis.* Holland.

ANGELICA

Puccinia karsteni, Lindr.

Teleutospores. Sori on the under surface of the leaves, mostly following the veins, also on leaf-stalks, minute, on yellowish spots; spores irregularly elliptical, tip rounded, not thickened, smooth, brown, 20—40 × 12—22 μ, pedicel short, deciduous.

On *Angelica sylvestris.* Sweden, Finland.

EPILOBIUM

Puccinia gigantea, Karst.

Teleutospores. Sori on under surface of the leaves and on the stem, scattered on the leaves, in long crusts on the stem, blackish-brown; spores oblong club-shaped or elongated spindle-shaped, tip rounded or narrowed, thickened, smooth, pale brown, 38—55 × 10—19 μ, pedicel as long as spore.

On *Epilobium angustifolium.* Switzerland, Sweden, Norway, Finland and Lapland.

GERANIUM

Puccinia geranii-silvatici, Karst.

Teleutospores. Sori on the under surface of the leaves and on the petioles, in clusters; spores elliptical, ends rounded, tip not thickened, upper cell warted, lower almost smooth, brown, 22—38 × 14—22 μ.

On *Geranium silvaticum.* Switzerland, Austria, Norway and Sweden.

Puccinia morthieri, Koern.

Teleutospores. Sori on the under surface of the leaves, in large round groups on red or yellow spots; spores oblong or oblong club-shaped, tip much thickened, base generally narrowed, constricted, smooth, brown, 40—65 × 18—24 μ, pedicel persistent, up to 80 μ long.

On *Geranium pratense* and *G. silvaticum.* Europe generally.

PRUNUS

Puccinia cerasi, Cast.

Uredospores. Sori minute, scattered or in groups on the under surface of the leaf; spores minutely warted, yellowish 17—30 × 15—20 μ, no paraphyses.

Teleutospores. Spores oblong, tip not thickened, usually rounded, slightly constricted, smooth, pale, 30—45 × 15—20 μ.

On *Amygdalus persica, Prunus avium, P. domestica,* and *P. spinosa.* Germany, Austria, France, and Italy.

ARABIS

Puccinia holboelli, Rostr.

Teleutospores. Sori mostly on the under surface of the leaf, generally scattered over the entire surface; spores oblong or somewhat club-shaped, tip rounded, thickened, slightly constricted, base narrowed, smooth, brown, 32—56 × 15—24 μ, pedicel persistent, up to 100 μ long.

On *Arabis alpina, A. hirsuta,* and *A. petraea.* Switzerland, Norway, Greenland, and California.

RANUNCULUS

Puccinia blyttiana, Lagh.

Teleutospores. Sori mostly on the under surface of the leaf, scattered or in groups; spores variable, mostly oblong, tip paler, scarcely constricted, with large, scattered warts, brown, 30—44 × 17—27 μ.

On leaves and petioles of *Ranunculus auricomus.* Norway and Switzerland.

TROLLIUS

Puccinia trollii, Karst.

Teleutospores. Sori on the under surface of the leaves, or on the leafstalks, usually forming one large patch; spores oblong or elliptical, tip with a broad wart, smooth, yellow or yellowish-brown, 28—52 × 16—25 μ.

On leaves of *Trollius europaeus.* This is not a British plant, but is commonly cultivated. Germany, Switzerland, Italy, Norway and Lapland.

POLYGONUM

Puccinia mammillata, Schroet.

Uredospores. Sori minute, scattered, on the under surface of the leaf, ochraceous; spores subglobose, aculeate, yellowish, 22—26 × 20—22 μ.

Teleutospores. Sori on brown spots; spores ovate or oblong, tip not thickened, with a pale wart, chestnut-brown, 28—38 × 16—21 μ.

On *Polygonum bistorta* and *P. vivipara.* Germany, Hungary, Sweden, and Russia.

GALANTHUS

Puccinia galanthi, Unger.

Teleutospores. Sori in groups or rings on pale spots, on both surfaces of the leaf; spores elliptical or oblong, tip not thickened, plicato-striate, brown, 30—48 × 20—27 μ.

On Snowdrop—*Galanthus nivalis.* Austria and Hungary.

ALLIUM

Puccinia allii, Rudolphi.

Uredosporse. Sori scattered or in groups, on both sides of the leaf; spores minutely echinulate, yellow, 22—33 × 18—25 μ.

Teleutospores. Spores variable in shape and size, oblong or club-shaped, tip thickened, slightly constricted, base often narrowed, smooth, brown, 35—80 × 17—30 μ, mesospores absent, paraphyses very numerous.

On *Allium schoenoprasum, A. carinatum, A. sativum,* and other species. Europe generally.

Distinguished from *Puccinia porri* in the flat, compact, hard, black sori of teleutospores, which remain covered by the epidermis.

JUNCUS

Puccinia junci, Winter.

Uredospores. Sori minute, scattered, rusty; spores minutely aculeate, pale brown, 16—28 × 15—20 μ.

Teleutospores. Sori scattered, minute, for a long time covered by the epidermis, blackish; spores club-shaped or somewhat spindle-shaped, tip much thickened, smooth, pale brown, tip darker, 35—60 × 12—24 μ, pedicel brownish, persistent.

On *Juncus compressus* and *J. gerardi.* Germany, Denmark and Norway.

CAREX

Puccinia schroeteriana, Kleb.

Aecidia. On the under surface of the leaves, on roundish, brownish-purple, yellow-edged patches, edge torn, whitish; spores minutely warted, orange, 13—22 μ.

Uredospores. On both sides of the leaf, minute, grouped on yellow spots; spores echinulate, brownish, 17—24 μ or 21—27 × 16—19 μ.

Teleutospores. Sori on small yellowish spots; spores club-shaped, tip much thickened and deeper coloured, constricted, smooth, pale brown, 38—55 × 16—22 μ.

Aecidia on leaves of *Serratula tinctoria.*

Uredospores and teleutospores on *Carex flava* and *C. vulpina.* Germany and Austria.

Puccinia silvatica, Schroet.

Pycnidia. Arranged in minute, honey-coloured groups.

Aecidia. On the under surface of the leaf, on yellow or brownish patches, often causing distortion, cup-shaped, edge recurved, torn, white; spores almost smooth, orange, 14—21 μ.

Uredospores. Sori minute, on the under surface of the leaf; spores echinulate, brown, 20—27 × 15—22 μ.

Teleutospores. Sori minute, blackish, on the under surface of the leaf; spores club-shaped, tip much thickened, base narrowed, pale brown, tip darker, 35—55 × 12—18 μ, pedicel tinged brown, firm.

Aecidia on *Taraxacum, Crepis, Lappa,* and *Senecio.*

Uredospores and teleutospores on *Carex alba, C. goodenoughii, C. oederi, C. silvatica,* and other species.

Europe generally.

Puccinia opizii, Bubak.

Pycnidia. On the upper surface of the leaf.

Aecidia. On the under surface of the leaf, on purplish,

rosy-edged spots, shortly cylindrical, edge torn, white; spores minutely warted, orange, 16—25 × 14—22 μ.

Uredospores. Sori on minute, yellow spots on the under surface of the leaf, spores variable in form, distantly echinulate, brown, 18—33 × 17—22 μ.

Teleutospores. Sori minute, black, for a long time covered by the epidermis; spores club-shaped or oblong club-shaped, tip much thickened and darker, base narrowed in to the pedicel, smooth yellowish-brown, 35—60 × 13—24 μ.

Aecidia on *Lactuca muralis* and *L. scariola.*

Uredospores and teleutospores on *Carex muricata.*

Germany, Austria, Sweden, and Finland.

AGROPYRUM

Puccinia agropyrinum, Erikss.

Uredospores. On both sides of the leaf, most abundant on the upper surface, sori scattered, minute; spores echinulate, yellow, 16—26 μ.

Teleutospores. Sori on the upper surface, minute, scattered or in lines, covered by the epidermis, black; spores oblong-clavate or clavate, tip scarcely thickened, base narrowed, smooth, brown, 36—56 × 13—18 μ, paraphyses tinged brown, numerous.

On *Agropyrum repens.* Germany, Austria, Italy, and Sweden.

HOLCUS

Puccinia holcina, Erikss.

Uredospores. Sori scattered or clustered, minute, oblong, yellowish-brown; spores echinulate, yellow, 20—28 μ.

Teleutospores. Sori scattered, or in lines on the sheaths, on both surfaces of the leaf, black; spores ellipsoid-clavate or clavate, tip scarcely thickened, slightly constricted, base usually narrowed, smooth, brown, 34—54 × 16—24 μ, paraphyses brown, numerous.

On *Holcus lanatus* and *H. mollis.* Austria, Hungary, Norway, Sweden, and Madeira.

ANTHOXANTHUM

Puccinia borealis, Juel.

Aecidia. In clusters on pale spots on the upper surface of the leaf, cylindrical, whitish, edge recurved and torn; spores minutely warted, orange, 13—18 μ, or 18—20 × 13—16 μ.

Uredospores. Sori oblong, on pale spots, generally on the upper surface of the leaf, orange; spores minutely echinulate, yellow, 18—22 μ.

Teleutospores. Sori minute, covered by the epidermis, on the upper surface of the leaf; spores more or less club-shaped, tip slightly thickened, base narrowed, smooth, brown, 35—45 × 13—20 μ, pedicel very short.

Aecidium on *Thalictrum alpinum.*

Uredospore and teletuospore on *Anthoxanthum odoratum.* Sweden and Norway.

CALAMAGROSTIS

Puccinia pygmaea, Erikss.

Uredospores. Sori minute, oblong, grouped on yellowish spots on the under surface of the leaf; spores minutely echinulate, yellowish, 24—32 μ, or 27—32 × 20—24 μ, paraphyses colourless, tip thickened.

Teleutospores. Sori very minute, scattered or in lines, remaining covered; spores club-shaped, tip usually truncate, slightly thickened, base narrowed, smooth, pale brown, tip darker, 32—42 × 12—16 μ, pedicel very short.

On leaves of *Calamagrostis epigeios, C. arundinacea,* and *C. halleriana.* Sweden, Finland, and Germany.

CYNODON

Puccinia cynodontis, Desm.

Uredospores. Sori minute, scattered or in lines; spores very minutely echinulate, pale brown, 19—28 μ diam.

Teleutospores. Sori scattered or in lines, black; spores elliptical or oblong, tip usually narrowed, much thickened, base rounded or slightly narrowed, smooth, brown, 30—60 × 15—25 μ, pedicel thick, brownish, long, persistent.

On *Cynodon dactylus.*

MILIUM

Puccinia milii, Erikss.

Uredospores. Sori on yellowish spots, scattered, or in lines, orange; spores echinulate, yellowish-brown, 20—26 μ diam.

Teleutospores. Sori oblong, minute, scattered or clustered, black; spores oblong club-shaped, tip blunt, scarcely thickened, base narrowed, smooth, pale brown, 28—41 × 13—21 μ, pedicel very short.

On *Milium effusum.* Sweden and Norway

PHLEUM

Puccinia phlei-pratensis, Erikss. and Henn.

Uredospores. Sori scattered on the leaves, in lines on the culms; spores aculeate, dingy yellow, 18—30 × 15—20 μ.

Teleutospores. Sori most abundant on the culms, blackish; spores club-shaped, tip thickened and usually narrowed, constricted, base narrowed, smooth, brown, 38—52 × 14—20 μ, pedicel tinged brown, rather stout, long.

On leaves and culms of *Phleum pratense.* Germany, Austria, Denmark, and Sweden.

PHRAGMITES

Puccinia obtusata, Ed. Fisch.

Aecidia. On the under surface of the leaf on large, round, yellowish or purple spots, cylindrical, then torn, whitish; spores polygonal, minutely warted, tinged yellow, 16—24 × 12—17 μ.

Teleutospores. Sori on both surfaces of the leaf, and on the culm, scattered or in very long patches, compact, blackish-brown; spores generally elliptical, ends rounded, tip scarcely thickened, not papillate, scarcely constricted, smooth, brown, 40—54 × 20—28 μ, pedicel stout, up to 200 μ long. A few uredospores sometimes mixed with the teleutospores.

Aecidium on living leaves of privet—*Ligustrum vulgare.*

Teleutospores on leaves and culm of *Phragmites vulgaris.* Germany and Switzerland.

TRITICUM

Puccinia actaeae-agropyri, Ed. Fisch.

Pycnidia. In small, honey-coloured groups.

Aecidia. Sori on pale spots of variable size, shortly cylindrical, whitish, edge recurved and torn; spores minutely warted, yellowish, 16—26 × 10—25 μ.

Uredospores. Scattered, minute, oblong, mostly on the upper surface of the leaf; spores echinulate, pale brown, 18—25 μ.

Teleutospores. Sori minute, scattered or in groups, on the under surface of the leaf, elongated, for a long time covered by the epidermis; spores oblong club-shaped, tip rounded or abrupt, thickened, base narrowed, smooth, brown, 32—45 × 14—26 μ, pedicel very short.

Aecidia on leaves of *Actaea spicata.*

Uredospores and teleutospores on living leaves of *Triticum caninum*. Switzerland.

APPENDIX

Form-genera ; forms which have not been respectively connected with any other form of reproduction. It is quite within the range of possibility that *Aecidium* and *Uredo* conditions may exist, which, at the present day, are not connected with any other form of reproduction, in the same way that certain uredines at the present day have only a teleutospore stage.

AECIDIUM

Spores produced in chains, enclosed in a special receptacle or pseudoperidium.

The contents of the spores are usually orange or yellow, the wall itself being colourless.

Aecidium leucospermum, D.C.

Pycnidia. Usually scattered over the entire surface of the leaves.

Aecidia. Shortly cylindrical, white, edge torn ; spores angularly globose, smooth, colourless, 15—26 μ diam.

On *Anemone nemorosa*.

As a rule all the leaves are attacked, and the habit and appearance of the plant is altered. Mycelium perennial.

Aecidium poterii, Cooke.

On the under surface of the leaves, in circular or elongated clusters, scattered or in concentric groups, also occurring on the leafstalks, immersed, edge torn into minute fugacious teeth ; spores yellowish, oval.

On *Poterium sanguisorba*. A doubtful production.

Aecidium phillyreae, D.C.

Aecidia numerous and densely crowded, edge torn or nearly entire, more or less incurved, whitish ; spores subglobose or somewhat irregular in form from mutual pressure, wall colourless, minutely warted, contents deep orange-yellow, 25—35 μ diam.

On leaves and young shoots of *Phillyrea latifolia*, L., Pevensey Churchyard, Sussex, Aug., 1907.

Every shoot of the year, including the leaves, was attacked and contorted by the parasite, and during the month of August were rendered conspicuous by the copious development of orange spores ; hence the pardonable mistake on the part of a local scientist, in stating that this

was the first occasion on which the bush had produced flowers.

A. phillyreae has been recorded on one previous occasion in England, being collected near Chichester on *Phillyrea media*, L. The specimens were seen by Dr. Cooke, who included the fungus in his handbook, as var. *phillyreae* of *Aecidium crassum*, Pers. No diagnosis of this variety was given ; hence the species has not become generally known to British mycologists. Plowright, p. 268, says : " This is a doubtful *Aecidium*, being little more than a condition of *Caeoma phillyreae*, as far as I have observed it." Now *C. phillyreae*, Thum., is a synonym of *Aecidium phillyreae*, D.C., and the latter is certainly a typical *Aecidium*, hence it may be concluded that Plowright was not familiar with the fungus. The occurrence of the fungus in this country is dependent on the distribution of its hosts, which are cultivated as ornamental shrubs. Search was made to ascertain whether the aecidiospores were capable of infecting any other plant growing in the neighbourhood of the diseased bush, but without success. The infected bush, which was a large one, and had been growing in the churchyard for many years, died the year following the epidemic described above.

The fungus is recorded from France, Germany, Italy, and Algeria.

Aecidium glaucis, Dozy and Molk.

Irregularly scattered, or sometimes arranged in circles forming clusters of variable size, shortly cylindrical or flattish, edge white, torn ; spores angularly globose, colourless, minutely warted, 16—25 × 15—20 μ.

On *Glaux maritima*.

Aecidium euphorbiae, Gmelin.

Scattered over the entire surface of the leaves, conical then cup-shaped, edge whitish, torn ; spores angularly globose, minutely warted, orange, 19—26 × 30—35 μ.

On *Euphorbia exigua*.

Aecidium pseudo-columnare, J. Kuhn.

Arranged in two rows on the under surface of the leaves, globose, ovate or elongated, edge irregularly torn ; spores colourless, minutely warted, ovate, elliptical or angular, 33—37 × 18—25 μ.

On *Abies pectinata, A. nordinaniana, A. amabalis* and *A. cephalonica*.

Infected leaves are paler in colour than healthy ones.

UREDO

Spores produced singly at the tips of slender hyphae, forming sori.

Uredo agrimoniae, D.C.

Sori roundish or irregular, often crowded and covering a large space on the under surface of the leaves; spores subglobose or ovate, minutely warted, orange, 17—23 × 14—17 μ.

On *Agrimonia eupatoria.*

Nature doubtful. Plowright says the sori are covered by rather thin pseudoperidia.

Uredo symphyti, D.C.

Sori minute, very numerous, yellow, on the under surface of the leaf; spores subglobose or ovate, minutely echinulate, yellow, 25—35 × 16—24 μ.

On *Symphytum officinale.*

Is this identical with the uredo form of *Puccinia bromina*, Eriksson?

Uredo mulleri, Schroeter.

Pycnidia on the upper surface of the leaf, on circular yellow spots.

Sori on both sides of the leaf, golden-yellow, often in rings; spores globose, echinulate, orange, 18—20 μ diam.

On leaves of bramble—*Rubus fruticosus.*

Uredo quercus, Brand.

Sori on the under surface of the leaves, circular, minute, scattered or clustered; spores subglobose, echinulate, orange-yellow, 15—25 × 12—15 μ.

On leaves of oak—*Quercus pedunculata.*

Uredo tropaeoli, Desm.

Sori minute, circular, scattered or crowded on pale yellow spots on the under surface of the leaves; spores ovoid or subglobose, orange.

On cultivated plants of *Tropaeolum aduncum.*

Uredo lynchii, B. and Br.

Sori small, pale, scattered, rarely clustered; spores yellow, obovate, echinulate, with short pedicels, 20—30 × 28—35 μ.

On exotic, cultivated species of *Spiranthes.*

Uredo polypodii, Pers.

This is now included under *Milesia.*

Uredo scolopendri, Fuckel.

This is now included under *Milesia.*

HEMILEIA, Berk. and Broome

Uredospores. Forming effused, powdery orange patches; spores in small heads or clusters borne at the tips of a cluster of hyphae which emerge through a stoma, 3—5 germ-pores present.

Teleutospores. Spores appearing in the centre of the head of uredospores after the latter are mature, 1-celled, broadly ovate and more or less umbovate, with one apical germ-pore; promycelium cylindrical, stout, 3-septate, each cell producing a single subglobose promycelium spore on a slender sterigma.

Closely allied to *Uromyces*, differing principally in the mycelium producing uredospores and teleutospores, emerging in fascicles or bundles through the stomata.

An exotic genus, of which two species have been introduced into this country on living orchids.

Hemileia vastatrix, Berk. and Broome, is the dreaded coffee-leaf disease, which has incurred the loss of many millions of pounds sterling and rendered impossible the cultivation of coffee in Ceylon. The disease is also rampant in the coffee plantations in Africa. It has not yet been recorded on coffee in the New World.

Hemileia americana, Mass.

Uredospores. Forming broadly effused, powdery, orange, coloured patches on the under surface of the leaf, spores shortly stipitate, globose, wall with minute, scattered warts, 24—32 μ.

Teleutospores. The spores occupy the central portion of the heads of uredospores, shortly stipitate, colourless, broadly obovate or turbinate, often with a small, obtuse, apical umbo, wall covered with minute warts, 30×25 μ.

Syn. *Hemileia oncidii*, Griff. and Maubl.

On living leaves of *Cattleya dowiana*, imported from Costa Rica.

Mycelium is very abundant in the tissues, haustoria are absent.

Mr. Grove has recorded a species of *Hemileia* from Ireland, parasitic on orchids, which he considers to be *H. phaji*, Sydow, but which in reality is *H. americana*, Mass.

The uredospores of *H. phaji* have the free convex portion covered with warts, whereas those portions of the spores in contact with each other are smooth, as in *H. vastatrix*.

On living leaves of *Phajus wallichii*.

GYMNOSPORANGIUM, Hedw.

Aecidia. Peridium elongated or horn-like, in clusters; spores produced in basipetal chains, with alternating sterile cells.

Teleutospores. Mass of spores more or less gelatinous when moist, horny when dry, usually forming rather large masses of a dull orange colour, and oozing out from the matrix; spores 1-septate, elongate, with 2—4 germ-pores.

The teleutospores of all species grow on Junipers, the mycelium is perennial in the branches, and the teleutospores are produced in the spring.

Gymnosporium sabinae, Winter; Plowr., *Ured.*, p. 230.

Aecidia. Produced on orange, then reddish, more or less circular, thickened spots, elongated or flask-shaped, pale brown, finally splitting lengthwise into shreds, which remain for a long time fixed together at the tip; spores subglobose, minutely warted, brownish, 30—45 μ.

Teleutospores. Mycelium perennial, causing spindle-shaped swellings on the branches, spore masses irregularly cylindrical or club-shaped, often flattened, blackish and firm, then reddish-brown and gelatinous; spores 1-septate, spindle-shaped, usually constricted at the septum, yellowish-brown or chestnut-brown, 35—55 × 20—30 μ, four germ-pores. Some teleutospores have a thin, colourless wall, in others the wall is thicker and dark coloured.

Aecidia on leaves of pear—*Pyrus communis*.

Teleutospores on branches of *Juniperus sabina*.

Gymnosporium clavariaeforme, Winter; Plowr., *Ured.*, p. 233.

Aecidia. Seated on yellow, thickened spots, at first flask-shaped, then cylindrical, pale brown, becoming torn into shreds at the tip; spores subglobose, minutely warted, pale brown, 25—45 μ diam.

Teleutospores. Mycelium perennial, causing spindle-shaped swellings of the branches, spore masses flattened, sometimes forked, firm, then gelatinous, pale orange; spores spindle-shaped, constricted at the septum, dark yellow, 70—120 × 15—25 μ.

Syn. *Tremella clavariaeformis*, Jacq.
Podisoma juniperi, Fries.
Aecidium laceratum, Sow.
Roestelia lacerata, Tul.

Accidia on *Crataegus oxyacantha*, and on pear—*Pyrus communis*.

Teleutospores on *Juniperus communis*.

Gymnosporangium juniperinum, Winter; Plowr., *Ured.*, p. 235.

Aecidia. On red or orange, more or less circular spots, cylindrical, curved, yellowish-brown, open and torn into shreds at the tip; spores subglobose, brown, finely warted, 21—28 × 20—25 μ.

Teleutospores. Spore masses at first dark brown, then orange, subglobose, gelatinous; spores of two kinds, one kind spindle-shaped, with a thick, brown wall, 70—80 × 25—30 μ, the other yellow, with a thinner wall, 65—75 × 16—20 μ, with six germ-pores. Mycelium perennial.

Aecidia on leaves of mountain-ash—*Pyrus aucuparia.*

Teleutospores on *Juniperus communis*.

Gymnosporangium confusum, Plowr., *Ured.*, p. 232.

Aecidia. Seated on thickened, more or less circular spots, orange, and often bounded by a red or brownish zone, cylindrical or cylindric spindle-shaped, splitting longitudinally and eventually torn into shreds; spores subglobose, pale brown, minutely warted, 15–20 μ diam.

Teleutospores. Spore mass at first knob-like, dark chocolate-brown, almost black, soon becoming cylindrical, often flattened, finally rich chestnut-brown, swelling when moist, and soon covered with golden-yellow promycelium spores; spores smooth, 1-septate, oval or elliptical, ends generally sharp, some spores have a colourless wall and orange contents, others have dark brown, thick walls, 40—50 × 20—25 μ, from 2—4 germ-pores, pedicel long, colourless.

Syn. *Aecidium mespili*, D.C.

Aecidia on hawthorn—*Crataegus oxyacantha;* medlar—*Mespilus germanica*; quince—*Pyrus vulgaris.*

Teleutospores on *Juniperus sabina.*

Often confounded with *Gymnosporium sabinae,* which the present closely resembles, and appears to depend mainly for its specific identity on not being able to infect pear leaves. Plowright points out, that when the aecidia occur on hawthorn, the spermogonial spots are more brightly coloured than those of *G. clavariaeforme.* The aecidiospores are also slightly smaller than those of the last-named species, and the cells of the peridia are delicately reticulated and longitudinally wrinkled. The mycelium of the teleutospore stage is perennial.

PHRAGMIDIUM, Link

Aecidia. Spores in chains, surrounded by paraphyses. *Uredospores.* Forming powdery sori surrounded by paraphyses.

Teleutospores. Spores forming small, black sori, large, cylindrical, composed of a single row of cells, 3—12-septate, apical cell with one germ-pore, the remainder each with, normally, four germ-pores, dark coloured, usually warted, pedicel usually long and stout, and swollen at the base.

There is no true peridium to the aecidia, as in the genus *Puccinia*. The sori of the aecidium and the uredo stages closely resemble each other superficially, forming yellow or orange, powdery patches, the aecidiospores, however, are produced in chains, whereas the uredspores are produced singly on pedicels. The teleutospores are composed of a single row of superposed cells, and differ from those of *Puccinia* in always having more than two cells, and in each cell, except the terminal one, having four germ-pores. *Phragmidium* is most closely allied to *Xenodochus:* for distinctions consult the last-named genus.

All the species are parasitic on plants belonging to the order Rosaceae. Many so-called species are described from various parts of the world, but probably no other genus of Uredines is more imperfectly understood, and apparently the method of infection experiments, which has cleared up so many doubtful points in the genus *Puccinia*, will alone clear up the tangle.

Phragmidium violaceum, Winter ; Plowr., *Ured.*, p. 223.

Aecidium. Sori on the under surface of the leaf, often in clusters, causing reddish spots, bounded by a purplish border, on corresponding parts of the upper surface of the leaf ; spores in chains, globose or broadly elliptical, echinulate, orange-yellow, 12—35 × 16—26 μ, paraphyses scanty.

Uredospores. Sori small, greenish-yellow, powdery ; spores globose, ovate or broadly elliptical, minutely warted, yellow, 20—30 μ.

Teleutospores. Sori on the under surface of the leaf as a rule, thickish, black, small ; spores cylindrical, 3—4-septate, coarsely warted, warts flattened and pale, dark brown, tip rounded, usually with quite a small wart-like point, 70—120 × 25—40 μ, four germ-pores in each cell, pedicel long, slightly thickened below.

Syn. *Puccinia violacea*, Schulz.
Phragmidium asperum, Wallr.
Lecythea ruborum, Lév.

On leaves of *Rubus fruticosus*, *R. hirtus*, *R. thyrsoideus*, *R. discolor*, *R. bifrons*, and probably on all our brambles. Europe generally.

Differs from *Phragmidium rubi*, Winter, which also occurs on brambles, in the absence of a long, colourless spine at the tip of the teleutospore.

Phragmidium rubi, Winter ; Plowr., *Ured.*, p. 224.

Aecidia and *Uredospores* similar to those of *P. violaceum*.

Teleutospores. Sori as a rule on the under surface of the leaf, small, scattered, black ; spores cylindrical, tip rounded and terminated by a long, colourless spine, coarsely warted, a few small warts are sometimes present on the spine at the tip, 5—7-septate, brown, 80—130 × 25—36 μ, pedicel long, stout, much swollen at the end.

Syn. *Puccinia rubi*, Pers.
Phragmidium incrassatum, Link.
Phragmidium bulbosum, Schl.

On leaves of *Rubus fruticosus*, *R. caesius*, *R. saxatilis*, *R. thyrsoideus*, and probably on most of our brambles. Europe, United States, Jamaica, India.

Phragmidium subcorticatum, Winter ; Plowr., *Ured.*, p. 224.

Aecidium. Sori on the under surface of the leaves, or often on the petioles or stem, where they form large, powdery orange-yellow patches ; spores subglobose or ovate, minutely echinulate, orange-yellow, 18—30 × 14—21 μ.

Uredospores. Sori soon powdery, yellowish-orange, often growing into each other and forming large patches ; spores globose or broadly elliptical, echinulate, yellow, 18—35 × 15—25 μ.

Teleutospores. Sori small, black, usually scattered over the entire surface of the leaf ; spores cylindrical, tip with a rather long, colourless point, rather coarsely warted, 5—9-septate, dark brown, 80—150 × 25—35 μ, cells with four germ-pores, pedicel long, swollen at the base.

Syn. *Uredo effusa*, Grev.
Uredo aurea, Purton.
Aregma mucronatum, Fr.
Phragmidium mucronatum, Fr.
Phragmidium bullatum, Westend.

On leaves and stems of *Rosa canina*, *R. centifolia*, *R. arvensis*, and on many kinds of cultivated roses. Europe, Syria, Persia, Natal, N. America, Jamaica, India.

This parasite often proves injurious to cultivated roses,

the large powdery orange patches of the aecidium and uredospore stages being very conspicuous.

Phragmidium rosae-alpinae, Winter ; Plowr., *Ured.*, p. 226.

Aecidia. Sori on the leaves, small and dot-like, on the stem large and powdery, orange ; spores angularly globose or elliptical, echinulate, 15—30 μ, paraphyses subglobose, almost colourless.

Uredospores. Sori small, yellow ; spores globose or broadly elliptical, echinulate, yellow, 15—25 μ.

Teleutospores. Sori very small, scattered on the leaf, black ; spores cylindrical, but narrowed at both ends and almost spindle-shaped, tip with a conical, colourless papilla, 7—11-septate, dark brown, warted, 100—170 × 20—30 μ, pedicel long, slightly swollen at the base.

Syn. *Phragmidium fusiforme,* Schroeter.

On *Rosa alpina.* Switzerland, Bavaria, Hungary. On various wild roses in the United States.

Phragmidium rubi-idaei, Winter ; Plowr., *Ured.*, p. 226.

Aecidia. Sori small, on the upper surface of the leaf, greenish-yellow, numerous, circular and usually with a small opening in the centre of the ring ; spores in short chains, echinulate, orange-yellow, 20—35 μ ; paraphyses subglobose, deep yellow.

Uredospores. Sori small, scattered, pale orange ; spores globose or broadly elliptical, yellow, 15—25 μ.

Teleutospores. Sori on the under surface of the leaf, usually numerous, scattered, black ; spores cylindrical, tip rounded or somewhat narrowed, with a conical, pale or colourless papilla, 5—9-septate, warted, dark brown and opaque, 100—160 × 20—37 μ, pedicel long, swollen at the base.

Syn. *Aregma gracile,* Grev.
Phragmidium gracile, Berk.
Puccinia gracilis, Grev.
Uredo rubi-idaei, Pers.
Uredo gyrosa, Reb.

On leaves of raspberry (*Rubas idaeus*). Only met with on the raspberry in Europe, but occurs on *Rubus occidentalis* in North America.

Phragmidium fragariastri, Schroet. ; Plowr., *Ured.*, p. 220 (in part).

Aecidia. Sori roundish, scattered or growing into each other and forming larger patches, especially on the stem and veins of the leaves, orange-yellow ; spores subglobose

or elliptical, minutely warted, orange-yellow, 18—28 × 15–20 μ, surrounded by club-shaped, curved paraphyses.

Uredospores. Sori small, orange-yellow, surrounded by club-shaped paraphyses; spores globose, ovate or broadly elliptical, echinulate, orange-yellow, 17—30 × 15—25 μ.

Teleutospores. Sori small, scattered, roundish, blackish; spores variable, cylindrical, tip rounded, sometimes with a small wart, 3—4-septate, brown, sometimes coarsely warted, more especially towards the tip, at other times almost smooth, with intermediate stages, 45—65 × 20—30 μ, pedicel usually shorter than the spore.

Syn. *Phragmidium fragariastri*, Schroet.; Plowr., *Ured.*, p. 220
Phragmidium obtusatum, Fries.
Phragmidium poterii, Fuckel.
Phragmidium sanguisorbae, Winter; Plowr., *Ured.*, p. 221.
Phragmidium potentillae, Winter; Plowr., *Ured.*, p. 221.
Phragmidium tormentillae, Fuckel; Plowr., *Ured.*, p. 222.

On *Potentilla fragariastrum*, *P. argentea*, *P. tormentilla*, and on other cultivated species, *Poterium sanguisorba*. Europe, Persia.

Examination of a large series of specimens proves that *P. sanguisorbae*, *P. potentillae*, and *P. tormentillae*, are but forms of *P. fragariastri*. There is every transition in the amount of warting of the teleutospore, from being coarsely warted, more especially towards the tip, to being almost perfectly smooth. There is sometimes a small wart at the tip of the teleutospore, sometimes not.

XENODOCHUS, Schlecht.

Aecidia. Forming rather large patches of a clear orange colour; spores in chains; paraphyses present.

Teleutospores. Forming blackish sori; spores very long, cylindrical, often bent, many-septate, pedicellate.

Differing from *Phragmidium* in the greater number of septa present in the teleutospores, and it is doubtful as to whether this constitutes a sound reason for separating the two genera.

Xenodochus carbonarius, Schlecht.; Plowr., *Ured.*, p. 227.

Aecidia. Forming rather large, orange-red patches,

becoming powdery; spores subglobose, minutely warted, 20—30 μ; paraphyses club-shaped, with yellow contents.

Teleutospores. Sori black, convex, often crowding into each other; spores very long, cylindrical, many-septate (12—25), consisting of a single row of superposed cells, constricted at the septa, dark brown, smooth, except at the tip of the chain, where the epispore is warted, 250—350 × 18—25 μ, pedicel short, persistent.

Syn. *Phragmidium carbonarium*, Winter.
Lecythea poterii, Lév.
Uredo miniata, Pers.

On living leaves of *Sanguisorba officinalis*.

Xenodochus curtus, Cooke.; Plowr., *Ured.*, p. 228.

Teleutospores. Sori minute, scattered, blackish; spores short, blunt, broad, 4—8-septate.

On leaves of *Valeriana officinalis*?

This is a doubtful species. There is no specimen in Cooke's herbarium at Kew, and it has not been observed by any one else.

CALYPTOSPORA, Kuhn.

Aecidia. Spores in chains, permanently enclosed in a peridium.

Teleutospores. Usually longitudinally 3-septate, forming brown spore-beds, germinating by the protrusion of a promycelium bearing secondary spores.

Syn. *Pucciniastrum*, Otth.

Recognised by the aecidial spores, when in chains, being connected by narrow necks, or intermediate sterile cells. The teleutospores are divided into component cells, standing side by side, by vertical septa. These component cells often separate at the septa, so that when old, the component cells might be mistaken for 1-celled teleutospores.

Calyptospora goeppertiana, J. Kuhn.

Aecidia. Cylindrical, whitish, becoming more or less torn into shreds towards the tip, arranged in two rows on the under surface of the leaves; spores produced in chains, orange-coloured, globose, warted, connected by intermediate narrow sterile cells, 16—22 μ.

Teleutospores. Cuboid or sometimes subglobose, generally vertically 3-septate, smooth, brown, up to 30 μ long, forming long, swollen patches on living stems, whitish, then pinkish, finally brownish-black.

Syn. *Pucciniastrum goeppertianum*, Klebahn.

The aecidium condition occurs in two rows, on one row each side of the midrib, on the under surface of the leaves of the silver fir—*Abies pectinata*, also on *Abies nordmannia*, *A. nobilis*, *A. magnifica*, A. *concolor*, *A. balsamea*, *A. fraseri*, *A. cilicia*, *A. cephalonica*, *A. pictita*, *A. pinsapa*, and *A. vietchii*.

The teleutospore stage grows on the shoots of the cowberry -*Vaccinium vitis-idaea* in this country, it occurs on *Vaccinium myrtillus* and on *V. chandleri* in the United States. Infected branches of the cowberry grow perfectly erect, and the entire plant is taller than healthy ones, and the leaves are stunted. The stem becomes much swollen and spongy, rosy, then brown, finally blackish. The teleutospores are produced in the epidermal cells of the swollen portion.

The silver fir suffers most in this country, but diseased specimens of *A. nordmannia* have also been sent to Kew from Wales.

ROSTRUPIA, Lagerh.

Uredospores. Sori flattened ; spores produced singly on short, colourless pedicels.

Teleutospores. Sori flattened; spores 2, many-septate, forming a single row of superposed cells, each cell having one germ-pore, coloured, enclosed in a pseudoperidium formed of closely compacted, coloured hyphae.

Distinguished from allied genera by the presence of a pseudoperidium composed of closely compacted, coloured hyphae, surrounding the teleutospore sorus. Aecidia are at present unknown.

Rostrupia elymi, Lagerh.

Uredospores. Sori on the upper surface of the leaf, solitary or grouped in lines and often running into each other, small, pale, paraphyses absent ; spores ovate, minutely echinulate, pale brown, usually 8 germ-pores.

Teleutospores. Sori small, often elongated, not very conspicuous ; spores generally 2—3-septate, cylindrical or somewhat spindle-shaped or club-shaped, very slightly or not at all constricted at the septa, tip blunt, base narrowed, smooth, pale brown, tip thickened and darker, pedicel very short, dark brown, persistent, surrounded by a pseudoperidium formed of closely compacted brown hyphae, which often rise up from the base, between the spores as a thin wall, thus dividing the sorus into 2—3 compartments.

Syn. *Puccinia elymi*, Westend.
Puccinia triarticulata, Berk. and Curt.

On leaves of *Elymus arenarius*. Belgium, Denmark, United States.

I met with this species some years ago on *Elymus arenarius* at Palling in Norfolk, in August.

COLEOSPORIUM, Lev.

Pycnidia. Orange, minute, somewhat conico-depressed.

Aecidia. In some species of two forms, one elongated, the other short.

Uredospores. Sori yellow, spores produced in chains, warted or minutely spiny.

Teleutospores. Sori forming flat, waxy, yellowish crusts; spores transversely 3-septate, each cell has one germ-pore; germination by a promycelium bearing a single promycelium spore at its tip.

Some species are heteroecious, others not. Some prove injurious to forest trees.

Coleosporium senecionis, Fries; Plowr., *Ured.*, p. 251.

Pycnidia. Yellow, minute, scattered.

Aecidia. On the leaves the peridia are cylindrical; on the bark, larger and irregular in form, often crowded, peridia whitish; spores in chains, globose or irregularly angular, orange, warted, 30—40 μ.

Uredospores. Sori reddish-yellow, soon pale and powdery; spores in short chains, soon becoming free and powdery, elliptical or subcylindrical, warted, 25—40 × 15—25 μ.

Teleutospores. Sori forming slightly convex, waxy crusts, yellowish-red, then deep red; spores cylindrical or somewhat club-shaped, tip flattened, generally 4-celled, brownish-orange, 80—110 × 20—35 μ, smooth.

Syn. *Aecidium pini*, Pers.
Peridermium pini, Wallr.
Trichobasis senecionis, Berk.
Coleosporium senecionis, Fries.
Puccinia glomerata, Cooke.

The uredospores and teleutospores are parasitic on groundsel—*Senecio vulgaris*: ragwort—*Senecio jacobaea*, and on other species of *Senecio*, as *S. viscosa*, *S. silvatica*, *S. palustris*, etc.

Pycnidia and aecidia grow on the leaves and bark of the Scots fir—*Pinus sylvestris*, *P. maritima*, *P. insignis*, *P. strobus*, etc.

Europe generally, Asiatic Siberia, and United States.

This species sometimes proves very injurious to conifers. Not much injury is done so long as the parasite is confined to the leaves, but when the trunk is attacked the mycelium becomes perennial in the bark, and causes deformation resulting in the death of the upper branches, producing the disease called "resin-top" or "resin-leader."

The uredo stage has been described as occurring on *Cineraria* leaves, and this is not at all improbable. On the other hand some authorities consider the fungus on *Cineraria* to be *Coleosporium sonchi*, Lév. Careful culture experiments can alone determine this point.

Coleosporium sonchi, Lév.; Plowr., *Ured.*, p. 250.

Uredospores. Sori yellowish-rufous, soon pale and powdery, irregular in shape, scattered or in groups; spores in short chains, soon becoming free, variable in shape, averaging 20—25 × 15—18 μ, orange, warted.

Teleutospores. Sori flat, orange then red, small, but sometimes crowded and forming crusts; spores cylindrical or club-shaped, generally 4-celled, tip flattened, orange, 60—70 × 20—25 μ.

Syn. *Uredo sonchi-arvensis*, Pers.
Uredo tussilaginis, Pers.
Coleosporium tussilaginis, Lév.

On Coltsfoot—*Tussilago farfara*, *Sonchus arvensis*, *S. oleraceus*, *Petasites officinalis*, *Inula helenium*, *Cacalia hastata*. Europe generally, Asiatic Siberia, and United States.

Coleosporium campanulae, Lév.; Plowr., *Ured.*, p. 251.

Uredospores. Sori on the under surface of the leaf, scattered, dull orange, soon pale and powdery; spores globose, angular or elliptical, at first in short chains, echinulate, 20—35 × 18—30 μ.

Teleutospores. Sori on the under surface of the leaf, often forming irregularly shaped, crusty patches, yellowish, then reddish-brown, finally blackish; spores cylindrical or club-shaped, generally 4-celled, smooth, orange, 80—100 × 20—30 μ.

Syn. *Uredo crustacea*, Berk.
Uredo campanulae, Pers.

On *Campanula rotundifolia* and *C. trachelium*, *Jasione montana*. Europe generally and Asiatic Siberia.

Coleosporium euphrasiae, Wint.; Plowr., *Ured.*, p. 253.

Uredospores. Sori mostly on the under surface of the leaf,

scattered or clustered, yellow, then pale ; spores in chains, irregular in shape, yellow, warted, 20—30 μ, sometimes up to 80 μ long.

Teleutospores. Sori on the under surface of the leaves, often crowded, orange then red, often mixed with uredospore sori; spores oblong or oblong club-shaped, held together by mucus, 4-celled, 80—110 × 20—30 μ.

Syn. *Uredo euphrasiae*, Schum.
Uredo rhinantheacearum, D.C.
Coleosporium rhinantheacearum, Lév.
Uredo melampyri, Rebent.

On *Melampyrum arvense, Bartsia odontites, Euphrasia officinalis, Rhinanthus crista-galli, Pedicularis palustris.* Europe generally.

TRIPHRAGMIUM, Link.

Pycnidia. Forming small, flattened, yellowish spots.

Uredospores. Of two forms. One appearing in the spring, sori large, orange colour ; the other in summer and autumn, sori small.

Teleutospores. Consisting of three cells, each of which is triangular in form, and joined firmly together, the three septa radiating from a central point, each cell has one germ-pore.

Distinguished from all other genera by the three cells forming the spore being grouped round a central point, so that the three septa radiate. The two side walls of each triangular cell, where it is in contact with an adjoining cell, are smooth, the free convex side of each cell is in some species covered with warts.

Triphragmium ulmariae, Link, Plowr., *Ured.*, p. 218.

Pycnidia. Appearing in the spring.

Uredospores. Spring form, forming large, powdery, orange patches, mostly on the veins and leafstalks, causing distortion of the parts attacked ; spores orange, minutely warted, oval or ovate, with a short pedicel, 20—30 × 18—24 μ. Summer and autumn form has small sori on the under surface of the leaves, orange; spores globose or elliptical, minutely echinulate, orange, 20—35 × 20—30 μ.

Teleutospores. Sori small, circular, black, persistent, becoming powdery, on the leaves and leafstalks ; spores normally 3-celled, subglobose, warted, chestnut-brown, 40—55 μ diam., pedicel colourless, persistent.

Syn. *Uredo effusa*, Berk.
Puccinia ulmariae, D.C.
Puccinia spireae, Purton.
Uromyces ulmarie, Lév.

On leaves of meadow-sweet—*Spiraea ulmaria*.

The spores are variable in form, sometimes only two cells are present, superposed as in *Puccinia*.

Triphragmium filipendulae, Pass. ; Plowr., *Ured.*, p. 219.

Uredospores. Early form having the spores oblong or pear-shaped, reaching up to 35 μ in length, orange. Summer form with orange, scattered, small sori ; spores globose or ovate, orange, with a colourless pedicel.

Teleutospores. Sori circular, scattered, blackish, soon becoming powdery : spores subglobose, yellowish, then brown, smooth, pedicel rather long, colourless.

Syn. *Uredo filipendulae*, Lasch.

As in *Triphragmium ulmariae*, the spores are sometimes only 2-celled, and are then indistinguishable in appearance, or mode of germination, from those of a *Puccinia*.

USTILAGINACEAE

The fungi constituting the present family are all parasitic on plants. The mycelium is very delicate, colourless and septate, and frequently permeates every part of the host-plant, more especially when a perennial or hibernating mycelium is present in some permanent part of the host. In other instances the mycelium is localised or confined to a limited area of the host-plant. Haustoria are present on the mycelium of some species.

The members of the present family are allied to the Uredinaceae in some points, the most important of which is, that in both families, the resting-spores or teleutospores produce, on germination, a promycelium which gives origin to promycelium spores. On the other hand, in the Ustilaginaceae the teleutospores originate within special branches of mycelium, which become swollen and more or less gelatinous, and eventually disappear, leaving the mature teleutospores dry and usually forming a powdery mass. In the Uredinaceae the spores are produced at the tips of specialised hyphae, which usually remain attached to the teleutospores at maturity. Uredospores are absent in the Ustilaginaceae. The earliest indication of spore formation in the Ustilaginaceae is the presence of globose swellings in the mycelium, which continue to increase in size for some time, such swellings are either formed at the tips of

branchlets, or intercalary, that is at intervals in the length of the mycelium. From the protoplasm contained in these swellings the spores are formed, and develop their own cell-wall while yet enclosed in the wall of the swelling. In the genus *Entyloma* spores are produced in all portions of the vegetative mycelium, whereas in *Ustilago* the spores are produced in special branches only. These branches, called *sporogenous hyphae*, are very much branched, and produced in great numbers at definite points of the host-plant. When about to produce spores, the sporogenous hyphae become broken up into a row of short cells by the formation of transverse cell-walls or septa, then the cell-walls of the hypha become much swollen and form a gelatinous envelope enclosing the protoplasm, which forms a single spore in each component cell of the hypha. The spores secrete their own cell-wall while yet enclosed in the gelatinised wall of the hypha, which eventually disappears, leaving the fully formed spores as a dry, powdery mass. In the genera *Urocystis*, *Tubercinia*, and *Sorosporium*, the spores form compact groups or clusters, known as *spore-balls*, surrounded by a special envelope formed of hyphae, which either persists or soon disappears. In *Urocystis* the envelope consists of empty pale coloured cells, which surround the cluster of dark coloured cells capable of germination. In *Doassanaia* the groups of cells are enclosed in a covering composed of closely compacted sterile cells, arranged in a parallel manner resembling the palisade tissue of a leaf. The mature teleutospores are usually brown, often with a tinge of violet or olive, and the epispore is frequently ornamented with warts or a raised network. Although uredospores are absent, delicate mildew-like tufts of conidiophores bearing minute, colourless conidia are present in the life-cycle of some species. The generic characters depend mainly on the mode of germination of the teleutospores, in fact it may be truly said that no member of the Ustilaginaceae can, with certainty, be referred to its genus until such measures have been taken. Details of the various modes of germination are given under the generic characters of the genera. A point of importance respecting the promycelium spores is, that they usually conjugate in pairs; that is, a pair of promycelium spores lying near each other, become organically joined by a short tube originating from one and becoming joined to the other, thus bringing the protoplasm of the two promycelium spores into contact. Such conjugation sometimes

takes place while the promyceliun spores are yet attached to the promycelium, but most frequently after they have become free. After conjugation a slender germ-tube is produced, into which the protoplasm from the two promycelium spores passes, and this germ-tube, under favourable conditions, is capable of entering a host-plant and starting an infection. In some species the germ-tubes, produced by promycelium spores that have conjugated, give origin to a second lot of spores called *secondary promycelium* spores, these give origin to germ-tubes capable of infecting a host-plant. The above described formation of promycelium spores and germ-tubes occurs when the spores germinate in water, but when germination takes place in a nutrient solution, as for instance in a wet manure heap, the result is different. Here the promycelium, instead of producing promycelium spores, forms a dense, branched mycelium, which eventually produces spores, or the mycelium continues to grow and produces myriads of minute cells resembling yeast-cells in appearance. Such spores do not conjugate, but are capable of infecting a host-plant.

USTILAGINACEAE

Fungi for the most part parasitic in the above-ground parts of living plants; mycelium usually wide-spread in the host, but soon disappearing; teleutospores produced within the hyphae, which often become gelatinous and disappear, on germination producing a promycelium which bears promycelium spores at the side, or at the tip. The promycelium spores usually conjugate in pairs, and afterwards develop a germ-tube capable of infecting a host-plant. In nutritive solutions the teleutospores often produce yeast-like cells by continuous budding or germination, in immense numbers.

KEY TO THE GENERA

I. *Teleutospores solitary, that is, not aggregated in groups.*

* Promycelium spores generally borne laterally on the promycelium, rarely at the tip. Sori powdery at maturity . . . . . *Ustilago*

** Promycelium spores numerous, borne at the tip of the promycelium.

† Sori powdery at maturity.

Wall of teleutospores generally ornamented with a network . . . . . *Tilletia.*

†† Sori not powdery at maturity.

(*a*) On stems or leaves.

Sori pale or brownish . . . . . *Entyloma.*

Sori broadly expanded, black . . *Melanotaenium.*

(*b*) On roots.

Forming blackish nodules . . . . . *Entorrhiza.*

(*c*) In the fruit.

Sori enclosed in a membrane formed of hyphae. *Sphacelotheca.*

II. *Teleutospores aggregated in compact groups forming spore-balls.*

* All the spores in a spore-ball of uniform size, and all capable of germination. Sori surrounded by a continuous layer of sterile cells, arranged side by side like the palisade cells of a leaf . . . *Doassansia.*

Sorus not enclosed in a special envelope formed of hyphae; mostly growing on leaves and stems. *Tuburcinia.*

Sori rufescent, generally produced in the fruit or seed. *Thecaphora.*

Sori consisting of spore-balls composed of minute spores of equal size and germinating capacity; otherwise like *Ustilago* . . . . . *Cintractia.*

Sori black, in the flowers of Caryophyllaceous plants. *Sorosporium.*

** Central cells of the spore-ball dark coloured and capable of germination, surrounded by pale coloured sterile cells.

The only genus . . . . . *Urocystis.*

NOTES ON THE GENERA

USTILAGO

Many of the species are known as "smuts," forming black sooty masses in the ears of wheat, oats, barley, etc. Others develop in the anthers of flowers, which produce instead of pollen, masses of black powder. Others again form black or brown streaks on leaves. All the species are parasites, and many select as hosts, grasses and sedges. The teleutospores are 1-celled, and comparatively minute.

TILLETIA

In some instances the spores are produced in the ovary, and fill the grain or seed with a mass of blackish spores, which in some species has a very disagreeable smell, somewhat resembling stinking fish. Others form streaks on

leaves. The teleutospores in several species have the wall covered with a network of raised ridges.

ENTYLOMA

Differing from the majority of genera in forming rather pale coloured spots or patches on leaves. Some species have a whitish, very delicate, mould-like conidial form of reproduction, which precedes the development of the sori of teleutospores.

MELANOTAENIUM

Our only species is parasitic on species of *Galium*; plants attacked are dwarfed and blackened by the parasite.

ENTORRHIZA

The only known British species forms small swellings on the roots of species of *Juncus*.

SPHACELOTHECA

The one species produces its spores in the ovary of species of *Polygonum*.

DOASSANSIA

Forming small pustules on leaves of aquatic plants, *Alisma*, *Comarum*, etc. Readily recognised on microscopic examination, by the wall of palisade-like hyphal cells surrounding the sorus.

TUBURCINIA

Forming conspicuous, swollen, black pustules on stem and leaves of *Trientalis europaea*. A delicate, white, conidial form, forms patches on the under surface of the leaves, before the teleutospores are developed.

THECAPHORA

Distinguished by the spore-balls being of a brownish colour. One species grows in the ovary of species of *Convolvulus*, the other in the inflorescence of *Carduus heterophyllus*.

CINTRACTIA

Superficially resembling *Ustilago* in habit, but the spores adhere in groups and form spore-balls. The only species in this country is an introduced one.

SOROSPORIUM

Spore-balls pale reddish-brown, produced in the ovary and anthers.

UROCYSTIS

Distinguished at once from every other genus, by the dark-coloured fertile spores of the spore-balls being surrounded by very pale, sterile cells.

USTILAGO, Pers.

Vegetative mycelium permeating the tissues of the host-plant, soon disappearing, spore-producing mycelium branched, becoming swollen and gelatinous, spores produced in rows in the tufted terminal branchlets, and forming a black, powdery mass at maturity; promycelium short, usually septate, bearing laterally, less frequently terminal, minute promycelium spores.

Many species form long, dark streaks on leaves and stems, others develop in anthers, others again in the ovary. In some forms there is a hibernating mycelium present in some permanent part of the host-plant, root, bulb, etc., which grows up yearly with the plant; such plants are diseased every season without being infected anew.

Many species prove very destructive to cereals, and from their very conspicuous appearance, more especially when the ears are attacked, and reduced to a black sooty-looking mass have received popular names, as "smut" and "slean." The bulk of species are parasitic upon either grasses or sedges, and when other groups of plants are attacked, a preference is shown for monocotyledons. Much work yet remains to be done before the true limits of our so-called species are clearly defined. Infection experiments alone can lead to this end. Some species can only infect the host-plant during its earliest seedling stage, others are infected during the flowering stage, hence no one preventive method will meet all cases. Where the seedling is infected, as in the case of oats, the spores adhering to the husk of the oats, when sown, germinate at the same time as the oat seedling, which becomes infected in the ground, the mycelium growing along with the oat plant, and finally producing its spores in the grain. In this case, if the oat seed is properly treated, so as to destroy all spores adhering to its surface, before sowing, the disease is checked. When the flower or foliage is the portion infected, the removal of diseased plants, cultivated or wild, that would furnish spores, should be attended to. In those cases where there is a perennial mycelium in the host-plant, no part of such, though apparently free from disease, should be used for propagation.

A. *Spores produced in the inflorescence, ovary, stamens, etc.*

Ustilago olivacea, Tul.; Plowr., *Ured.*, p. 277.

Produced in the ovary, soon powdery, olive-brown, then blackish; spores irregular in form and size, angularly globose or elongated, pale brownish-yellow or tinged olive, wall almost smooth, or minutely spinulose, 5—7 μ diam., or 5—16 × 3—5 μ.

Syn. *Erysibe olivacea,* Wallr.
Uredo olivacea, D.C.
Caeoma olivaceum, Link.

In the ovary of *Carex arenaria, C. rostrata, C. riparia, C. ampullacea, C. vesicaria.* France, Germany, and Belgium.

Ustilago caricis, Fuckel; Plowr., *Ured.*, p. 276.

Spore-masses black, firm, produced in the ovary, and forming a globose, black mass; spores irregular in shape, globose, elliptical or polygonal, often compressed, wall dark brown, very minutely granular, 12—24 × 7—20 μ.

Syn. *Uredo urceolarum,* D.C.
Ustilago montagnei, Berk. and Broome.
Ustilago urceolarum, Tul.

On *Carex praecox, C. stellulata, C. recurva, C. glauca, C. dioica, C. vulgaris, C. panicea, C. pseudocyperus, C. hirta, Rhyncospora alba, R. fusca.* Europe generally, Asiatic Siberia, N. and S. America.

Ustilago nuda, Jensen.

Spore-masses formed in the ears of cultivated barley, the whole ear soon becoming covered with a black powdery mass that is soon dispersed; spores subglobose to elliptical, olive-brown, smooth, 5—9 μ.

Syn. *Ustilago segetum,* Dittm. (in part); Plowr., *Ured.*, p. 273 (in part).

Attacking the ears of cultivated barley—*Hordeum vulgare.* This parasite is commonly known as "loose smut of barley," whereas *Ustilago hordei* is called "covered smut." Both are at times very destructive to cultivated barley. The present species infects the host-plant during the flowering stage, through the stigma.

Ustilago hordei, Jensen.

Spore-masses formed in the ovary, remaining hard and persistent, and not becoming powdery, black, being surrounded by the unbroken wall of the grain for a long time; spores subglobose, blackish-brown, smooth, size somewhat variable, 6—9 μ.

Syn. *Ustilago segetum*, Dittm. (in part); Plowr., *Ured.*, p. 273 (in part).

Occurring in ears of cultivated barley—*Hordeum vulgare*. The plant is not infected in the seedling stage, hence it is no use treating the seed. Infection takes place during the flowering stage, through the stigma, and the grain becomes infected, but shows no sign of injury.

Ustilago segetum, Dittm.; Plowr., *Ured.*, p. 273 (in part).

Sori produced in the inflorescence, black, then olive-brown, soon powdery; spores globose, angularly globose or oblong, yellowish, then olive-brown, smooth or minutely granulated, 5—8 μ; promycelium cylindrical, generally 3-septate, promycelium spores minute, elliptical, springing for the most part from the septa, sometimes from the tip.

Syn. *Reticularia segetum*, Bull.
Uredo carbo, D.C.
Uredo segetum, Pers.

Produced in the pedicels and ovary, which are soon destroyed; *Festuca pratensis, Arrhenatherum elatior, Cynodon dactylis, Avena flavescens, Aira caespitosa, Lolium perenne, L. temulentum*. Europe generally, Africa, Siberia, Japan, Queensland, N. and S. America.

Ustilago sorghi, Pass.

Spore-mass produced in the ovary, rarely in the stamens, soon black and powdery; spores globose, angularly globose, or oblong, yellowish olive-brown, smooth, 6—9 μ; promycelium cylindrical, narrowed at the point of emergence from the spore, promycelium spores oblong.

On *Sorghum saccharatum*, growing in Kew Gardens. Cannot be considered as a British species.

Ustilago maydis, Corda; Plowr., *Ured.*, p. 278.

Produced in the inflorescence, also on the stem and leaves, in the inflorescence forming very large warts at first covered by the wrinkled epidermis; spores globose or shortly elliptical, yellowish-brown, minutely spinulose, 8—13 × 8—11 μ; promycelium cylindrical, slender, promycelium spores spindle-shaped, borne at the septa and at the tip of the promycelium.

Syn. *Uredo zeae-mays*, D.C.
Ustilago zeae-mays, Winter.
Caeoma zeae, Link.

On cultivated Indian corn—*Zeae mays*. This parasite often proves very destructive in countries where Indian corn is cultivated as a crop.

Ustilago bromivora, Fischer *de Waldh.*; Plowr., *Ured.*, p. 278.

Produced in the unexpanded inflorescence, forming lumps which burst and become powdery, blackish-brown; spores globose, elliptical, or ovate, dusky brown, almost smooth, or indistinctly granular, 8—14 × 6—10 μ, promycelium cylindric spindle-shaped, mostly 1-septate, soon disappearing, promycelium spores both terminal and lateral, spindle-shaped.

Syn. *Ustilago carbo*, var. *vulgaris, d. bromivora*, Tul.

On *Bromus mollis, B. secalinus, B. madritensis, B. uniloides.* Germany and S. America.

Ustilago cardui, Fischer *de Waldh.*; Plowr., *Ured.*, p. 282.

Spores produced in the inflorescence, soon becoming powdery, dusky brownish-violet; spores globose or elliptical, brownish-violet, pale brown when old, wall covered with a rather large-meshed network, 15—20 × 11—15 μ.

Syn. *Ustilago russiana*, Kuhn.

Produced in the ovaries of *Carduus acanthoides* and *C. nutans.* Germany.

Ustilago tragopogi, Schroet.; Plowr., *Ured.*, p. 281.

Sori produced in the inflorescence, blackish-violet, at first concealed by the involucral scales; spores generally irregularly globose, sometimes broadly elliptical, wall dusky-violet, covered with a small-meshed network, 13—17 × 10—15 μ; promycelium cylindrical, 3-septate, promycelium spores elliptic-oblong, borne at the septa.

Syn. *Uredo tragopogonis*, Roehl.
Uredo receptaculorum, D.C.
Ustilago purpurea, Bon.

On *Tragopogon pratensis.*

The whole of the inflorescence is destroyed, and the involucre remains closed. Europe generally.

Ustilago violacea, Fuckel; Plowr., *Ured.*, p. 280.

Sori produced in the anthers, rarely in the ovary, pale or dusky violet, soon powdery; spores globose or shortly elliptical, pale violet, wall with a very small-meshed network, 6—9 μ; promycelium spindle-shaped, 1—3-septate, promycelium spores produced singly at the septa or at the tip, elliptical.

Syn. *Uredo violacea*, Pers.
Farinaria stellariae, Sow
Ustilago antherarum, Fr.
Uredo antherarum, D.C.
Caeoma violaceum, Mart.

On *Silene inflata, S. maritima, S. nutans, Cerastium viscosum, Stellaria graminea, S. holostea, Lychnis flos-cuculi, L. diurna, L. vespertina, Dianthus deltoides, Saponaria officinalis.* Europe generally and N. America.

Ustilago major, Schroet. ; Plowr., *Ured.*, p. 280.

Spore-mass produced in the anthers, soon powdery and dusky violet ; spores globose or elliptic-oblong, wall violet, with a very fine-meshed network, 7—13 × 7—9 μ.

In anthers of *Silene otites.*

Ustilago scabiosae, Winter.

Mass of spores pale pink, becoming more or less violet colour, produced in the anthers, and at maturity covering the entire flower-head ; spores globose or rarely elliptical, pellucid, tinged brownish or dingy lilac, wall covered with a polygonal-meshed network, 8—10 μ diam. ; promycelium cylindrical, generally 3-septate, promycelium spores elliptical, borne singly at the septa, sometimes also at the tip.

Syn. *Farinaria scabiosae,* Sow.

Ustilago flosculorum, Fr. ; Plowr., *Ured.*, p. 279.

In anthers of *Knautia arvensis, Scabiosa arvensis, S. succisa,* and *S. columbaria.* Germany, France, Switzerland.

Ustilago utriculosa, Tul. ; Plowr., *Ured.*, p. 280.

Spores produced in the ovary and in the filaments of the stamens, dusky violet, soon powdery ; spores globose or elliptical, bright violet, brownish-violet when dry, wall with a rather large, polygonal-meshed network, 9—14 μ ; promycelium cylindrical, 3-septate, promycelium spores produced in pairs at the septa.

Syn. *Ustilago persicariae,* Chr.

Uredo utriculosa, Duby.

In the ovary and filaments of *Polygonum lapathifolium, P. persicaria, P. aviculare, P. convolvulus,* and *P. hydropiper.* Europe generally, N. and S. America.

Ustilago vinosa, Tul. ; Plowr., *Ured.*, p. 278.

Produced in the ovary, filling the fruit with a blackish-violet powder ; spores irregularly globose, rarely oblong, pale violet, wall with rather large hemispherical warts, 12 × 6—10 μ.

Syn. *Uredo vinoso,* Berk. *in litt.*

Ustilago vinosa, Tul.

In the ovary of *Oxyria reniformis.* Switzerland and Finland

Ustilago vaillantii, Tul.

Spore-masses produced in the anthers, less frequently in the ovary, olive-brown then black, soon powdery; spores irregularly globose, oblong or elliptical, wall yellowish-brown, smooth or minutely granulated, 7—15 × 8—12 μ; promycelium spindle-shaped, 1-3-septate, promycelium spores spindle-shaped, borne singly at the septa and at the tip.

On *Scilla bifolia, Gagea lutea.*

Not at all uncommon in gardens on *Scilla bifolia.* The mycelium of the fungus is perennial in the stem or "cushion" of the bulb, where it forms very conspicuous haustoria. This mycelium grows up each year with the flowering stem.

Italy, Germany, Austria, Hungary, and N. Africa.

B. *Spores produced on the leaves, stem or culm.*

Ustilago grandis, Fries; Plowr., *Ured.*, p. 275.

Forming long streaks on the culms beneath the leaf-sheaths, soon becoming black and powdery; spores angularly globose or elongated, wall smooth, yellowish-brown, 6—8 μ, or 8—14 × 6—9 μ; promycelium cylindrical, indistinctly 2—3-septate; promycelium spores terminal and lateral, elliptic spindle-shaped, stalked.

Syn. *Ustilago typhoides,* Berk. and Broome.

On *Phragmites communis, Typha latifolia,* and *T. minor.* Germany, Belgium, Finland, and Hungary.

Ustilago longissima, Tul,; Plowr., *Ured.*, p. 272.

Forming very long brown streaks on the leaves, mostly on the upper side, which soon become powdery; spores globose or elliptical, pale olive-brown, smooth, 4—8 μ; promycelium spindle-shaped, narrowed at the base; promycelium spores spindle-shaped.

Syn. *Uredo culmorum,* Schum.

Erysibe longissima, Wallr.

On leaves of *Glyceria aquatica, G. fluitans* and *Phalaris arundinacea.*

Forming thin, brown, parallel streaks on leaves, often several inches in length. The myceliuín is perennial in the rhizome, hence when a plant is once infected, it produces the disease ever afterwards.

Europe generally, N. and S. America.

Ustilago salveii, Berk. and Broome.

Sori forming long streaks on the leaves, at first covered by the epidermis, then powdery and brown; spores globose,

pale brown, with rather large, distant, subglobose warts, 9—14 μ.

Syn. *Tilletia striiformis*, Plowr., *Ured.*, p. 284.

On leaves of a grass.

This species has been referred to *Tilletia striiformis*, Magnus, but an examination of Berkeley's type, in the Kew Herbarium, shows that the two are quite distinct. The true position can only be determined when the fungus is met with again, and the germination of the spores observed.

Ustilago hypodytes, Fries ; Plowr., *Ured.*, p. 273.

Forming narrow, black, parallel streaks on the culm, at first concealed by the leaf-sheaths, soon forming a blackish-olive, powdery mass ; spores angularly globose or elongated, wall smooth, yellowish olive-brown, 3—6 μ, some few often much larger.

Syn. *Uredo hypodytes*, Desm.
Ustilago lygei, Rabenh.

On *Glyceria fluitans*, *Agropyrum repens*, *Triticum junceum*, *Avena flavescens*, *Elymus arenarius*, *Bromus erectus*, *Phragmites communis*, *Psamma arenaria*, *Stipa pennata*.

Europe generally, N. Africa and N. America.

Ustilago grammica, Berk. and Broome ; Plowr., *Ured.*, p. 275.

Forming bands at equal distances, on the culm, the bands are formed of rather closely packed parallel streaks encircling the culm, 2 —3 lines in length ; spores subglobose, smooth, pale brown, 2.5—3 μ.

On *Glyceria fluitans*, *G. aquatica* and *Aira caespitosa*.

Remarkable for its habit of growing in encircling zones, composed of blackish streaks, at equal intervals on the culm.

Ustilago bistortarum, Korn. ; Plowr., *Ured.*, p. 277.

Sori on both sides of the leaf, scattered or gregarious, rather large, blackish-violet after bursting through the epidermis ; spores subglobose or elliptical, brownish-violet, 13—16 μ, indistinctly granulated.

Syn. *Tilletia bullata*, Fuckel.
Ustilago bullata, Schroet.
Caeoma bistortarum, Link.

On *Polygonum bistorta* and *Rumex obtusifolius*.

Germany, Austria, and Finland.

A variety called var. *glabra*, Rostr., having smooth spores, 12—13 μ, occurs on leaves of *Polygonum viviparum*, in Finmark, which may be met with in this country.

Ustilago kuhneana, Wolff ; Plowr., *Ured.*, p. 281.

On the stem, leaves and flowers, forming patches or streaks, rusty violet ; spores globose or angularly globose, dusky violet, wall covered with a network, 10—16 μ ; promycelium 2—3-septate, promycelium spores very minute.

On *Rumex acetosa* and *R. acetosella*. Germany and Italy.

C. *Spores produced on the root, rhizome, etc.*

Ustilago marina, Durieu ; Plowr., *Ured.*, p. 275.

Forming blackish-brown, swollen sori on the root of the host-plant ; spores of two kinds, one form subglobose or broadly egg-shaped, 10—13 μ, the other irregularly elliptical or egg-shaped, 16 × 10—13 μ, wall thick, pale olive-brown, smooth.

On rhizomes of *Scirpus parvulus*.

A very doubtful species, respecting which but little is known.

Ustilago hypogaea, Tul. ; Plowr., *Ured.*, p. 276.

Forming blackish, compact sori round the root of the host-plant ; spores subglobose or polygonal, dark brown, smooth, crowded with oil-globules, 20—24 × 14—20 μ.

On the rootstock of *Linaria spuria*.

A doubtful species.

TILLETIA, Tul.

Parasites developing in the interior of plant tissues. Spore-mass blackish and powdery when mature, often foetid, especially when moist. Spores produced singly at the tips of somewhat gelatinous, swollen, fertile hyphae, at first covered by the epidermis. On germination the spores produce a promycelium, which bears a terminal whorl of slender secondary spores. These secondary spores usually conjugate in pairs, and on again germinating give origin to slender, elongated conidia.

The principal feature of the present genus consists in the free spores forming a dry, powdery mass at maturity, and the production on germination, of a whorl of secondary spores at the tip of the promycelium.

Entyloma agrees in having free spores, and in the mode of germination, but the spores do not form a dry, powdery mass when mature.

In *Urocystis* the spore-mass is dry and powdery when mature, but the fertile spores are in small clusters, which are surrounded by colourless, sterile cells.

The genus is widely distributed throughout the world, whereas the species are mostly restricted in their range, each being limited to a portion of one Continent, with the exception of those species parasitic on cultivated cereals, which have been distributed by artificial means.

All the British species grow on grasses.

A. *Spore-mass produced in the ovary.*

Tilletia caries, Tul.

Spore-mass produced in the ovary, blackish, with a tinge of olive, foetid; spores subglobose, brown, 17—22 μ, border 1—1.5 μ broad, not paler, epispore covered with a network of rather large mesh of variable size, averaging 3—3.5 μ across.

Syn. *Tilletia tritici,* Wint.; Plowr., *Ured.,* p. 283.
Uredo caries, D.C.

On wheat—*Triticum vulgare, T. spelta, T. monococcum.*

Europe generally, Algeria, Queensland, Victoria, United States, Chili.

Tilletia rauwenhoffi, Fischer ~~de~~ Waldh.

Spore-mass produced in the ovary, blackish; spores almost constantly globose, olive-brown, 25—30 μ, epispore with a large irregularly hexagonal network, mesh averaging 3—4 μ across.

Syn. *Polyactis holci,* Westend.

On *Holcus lanatus* and *H. mollis.*

Readily distinguished by the large size of the network of the epispore, only 4—6 areolae being present on a hemisphere.

The first recorded British specimens were collected by the late Mr. T. Soppitt, at the Doncaster Meeting of the Yorkshire Naturalists' Fungus Foray, 1891.

Tilletia laevis, Kuhn.

Spore-mass produced in the ovary, deep brown with an olive tinge, very foetid; spores subglobose or elliptic, variable in size and form, 17—21 μ, or 15—26 × 10—15 μ, wall about 2 μ thick, pale brown or almost cream-colour, wall smooth.

Syn. *Ustilago foetens,* Berk. and Curt.

On wheat—*Triticum vulgare.*

The spore-mass, more especially when rubbed, has a smell resembling rotten fish.

Europe generally, United States, and Victoria.

Tilletia separata, Kunze.

Spore-mass formed in the ovary, blackish-brown, foetid;

spores irregularly globose, or broadly elliptical, clear brown, 20—27 μ, border about 3 μ wide, not much paler, epispore covered with a small meshed network, mesh averaging 1.5—2.5 μ in diameter.

Syn. *Tilletia decipiens*, Wint. ; Plowr., *Ured.*, p. 284.
Tilletia secalis, Kuhn.
Uredo secalis, Corda.

On rye—*Secale cereale, Agrostis vulgaris, A. alba, Apera spica-venti. Agrostis pumila, L.*, is only *A. vulgaris* dwarfed by the *Tilletia*.

Distinguished from *Tilletia caries* by the wider border of the spore, and the smaller meshes of the network.

France, Germany, Switzerland, Russia.

B. *Spore-mass formed on the leaves or culm.*

Tilletia berkeleyi, Mass.

Spore-mass forming blackish streaks up to half-an-inch long, on the culm, not foetid when moistened ; spores constantly globose, brown, 15—18 μ, border 1 μ wide, epispore with a very delicate, small-meshed network, mesh averaging 1.5 μ across.

On wheat—*Triticum vulgare.*

Differs from all species in the small size of the spores ,and in the very delicate, small-meshed network on the epispore.

Tilletia debaryana, Fischer de Waldh.

Spore-mass blackish-brown, forming long streaks on the leaves of the host-plant ; spores subglobose or broadly elliptical, brown, wall densely covered with minute, dark-topped warts formed by the breaking up of the epispore, 10—18 μ.

Syn. *Tilletia striaeformis*, Wint. ; Plowr., *Ured.*, p. 284.
Tilletia serpens, Karst.
Tilletia brizae, Ule.
Uredo striaeformis, Westend.

Parasitic on many different grasses—*Briza media, Anthoxanthum odoratum, Lolium perenne, Brachypodium pinnatum, Agrostis alba, A. vulgaris, Arrhenatherum avenaceum, Bromus inermis, Dactylis glomerata, Festuca elatior, F. ovina, Holcus lanatus, H. mollis, Milium effusum, Phleum pratense, Agropyrum repens, Alopecurus pratensis*, etc.

Europe, except Russia and the Mediterranean region, United States.

ENTYLOMA, De Bary

Mycelium intercellular, not becoming gelatinised ; spores produced singly, terminal or interstitial, often produced in

clusters, wall thick, usually composed of several layers, colourless or brownish, smooth or ornamented in various ways; promycelium slender, bearing long, slender, promycelium spores at the tip (as in *Tilletia*) which often conjugate in pairs. Conidia are present in some species, forming delicate white mould-like tufts on the leaves of the host-plant.

The conidial condition was at one time included in the genus *Cylindrosporium* belonging to the *Hyphomycetes*. *Entyloma* is closely allied to *Melanotaenium*, the latter, however, differs in forming black sori.

Entyloma fergussoni, Plowr., *Ured.*, p. 289.

Spots circular, rather large, greyish on the under surface of the leaf, due to the presence of conidia; spores subglobose or broadly elliptical, wall rather thin, pale brown, smooth, 10—15 μ; conidial cylindrical, continuous, 30—45 × 2.5—3 μ.

Syn. *Entyloma canescens*, Schroet.

Protomyces fergussoni, Berk. and Broome.

On Forget-me-not—*Myosotis palustris*, *M. arvensis*, *M. caespitosa*.

Germany.

Entyloma bicolor, Zopf; Plowr., *Ured.*, p. 290.

Forming rather large oblong spots, brownish above, greyish-white on the opposite side from the conidia; spores irregularly globose or elliptical, 20—23 × 12—18 μ, wall gelatinous, of variable thickness, colourless, then brown; conidiophores simple or branched, tufted, springing from a compact mass, conidia cylindrical, curved, base narrowed, tip rounded, sometimes septate, 10—22 × 3 μ.

On *Papaver rhoeas* and *P. dubium*.

Germany.

Entyloma ranunculis, Schroet.; Plowr., *Ured.*, p. 290.

Spots variable in size, often several on a leaf, whitish, then brownish, at first covered with the conidial stage; spores globose, wall thin, pale brown, 11—16 μ; conidia long, spindle-shaped or quite slender, 30—40 × 2—3 μ.

Syn. *Gloeosporium ficariae*, Berk.

On Pilewort—*Ficaria ranunculus*, common also on *Ranunculus repens* and *R. sceleratus*.

France, Germany, Italy, and Austria.

Entyloma trailii, Mass.

Forming spots on the stem and leaves, small, whitish, while the conidia are present, afterwards brown and dry;

spores abundant, round or polygonal from mutual pressure, wall smooth, colourless, then brown, 10—12 μ; conidiophores coming in clusters through the stomata; conidia elongated, spindle-shaped or slender, tinged yellow, becoming faintly 3—4-septate, 15—20 × 1.5—2 μ.

Syn. *Entyloma matricariae*, Trail, in Plowr., *Brit. Ured.*, p. 291.

On *Matricania inodora*.

Allied to *Entyloma matricariae*, but in the latter the conidia are elliptical, and measure 4—6 × 2—2.5 μ.

Entyloma chrysospleni, Schroet.; Plowr., *Ured.*, p. 291.

Forming rather large spots, at first whitish, then becoming tinged yellow; spores globose or broadly elliptical, wall thin, smooth, almost colourless, 10—12 μ.

Syn. *Protomyces chrysoplenii*, Berk. and Broome.

On *Chrysosplenium oppositifolium*.

Germany.

Entyloma calendulae, De Bary; Plowr., *Ured.*, p. 292.

Spots more or less circular, sometimes rather large, whitish or tinged green, then brownish; spores subglobose, wall thin, almost colourless, smooth or tinged yellow, 9—16 μ.

Syn. *Protomyces calendulae*, Cooke.

On leaves of *Calendula officinalis*, *Hieracium murorum* and *H. vulgatum*.

France, Germany, Argentine Republic.

Entyloma microsporum, Schroet.; Plowr., *Ured.*, p. 291.

Spots remaining under the cuticle of the host-plant, rather prominent, circular or elongated, whitish, then tinged yellow or brownish; spores produced between the cells of the host-plant, often in superposed rows, irregularly globose, wall thick, 3—6 μ, formed of several strata or layers, 15—24 × 12—18 μ.

Syn. *Protomyces microsporus*, Ung.
Entyloma ungerianum, De Bary.

On leaf-stalks and leaves of *Ficaria ranunculus*, *Ranunculus repens*, *R. bulbosus*, and *R. acris*.

Germany, Finland, and United States.

MELANOTAENIUM, De Bary

Mycelium intercellular, or running between the cells, producing flattish grey or blackish spots; spores produced singly in the mycelium, but in clusters, not becoming dry and powdery, wall thick, not stratified; germination as in *Entyloma*.

Our only species is parasitic on various species of *Galium* ; infected plants are dwarfed and blackened.

Melanotaenium endogenum, De Bary ; Plowr., *Ured.*, p. 292.

The spores form expanded black patches or sori, remaining covered by the epidermis of the host-plant ; spores globose or elliptical, blackish-brown, smooth, size variable, averaging 15—22 × 12—20 μ ; promycelium usually having a sterile branch at the base, promycelium spores cylindrical, often conjugating in pairs and germinating at once.

Syn. *Protomyces galii*, Rabenh.
Protomyces endogenus, Ung.

On *Galium verum* and *G. mollugo*.

Infected plants are much dwarfed and blackened by the parasite.

ENTORRHIZA, C. Weber

Mycelium growing within the cells of the host-plant, bearing large spores at the tips of lateral branchlets, one or several in a cell, wall thick ; result of germination one or more slender promycelium tubes, which sometimes bear branchlets, promycelium spores slender, curved, very minute, borne at the tip of the promycelium and at the tips of the branchlets.

Forming small swellings on the roots of plants. The minute, slender, curved promycelium spores are characteristic.

Entorrhiza aschersoniana, De Toni.

Spores elliptical or sometimes more or less pointed at one end, yellowish, then chestnut-brown, wall crowded with rather large warts, 15—17 × 11—15 μ ; promycelial spores very minute.

Syn. *Entorrhiza cypericola*, Weber ; Plowr., *Ured.*, p. 299.
Schinzia aschersoniana, Magnus.

On the roots of *Juncus bufonius*, *Juncus lamprocarpus*, *J. uliginosus*, and *J. squarrosus*.

Germany.

SPHACELOTHECA, De Bary

Spores produced in the ovary, contained in a receptacle formed of hyphae, with a central column or columella, the receptacle becoming open at the tip ; spores coloured, smooth ; germination by a promycelium producing promycelium spores laterally, as in *Ustilago*.

Readily known by the presence of an enclosing wall or receptacle and a columella formed of hyphae.

Sphacelotheca hydropiperis, De Bary; Plowr., *Ured.* 282.

Spore-mass produced in the ovary, which becomes swollen and projects beyond the perianth, the receptacle becoming open at the tip, when the spores escape as a blackish-violet powdery mass; irregularly globose or elliptical, wall blackish-violet, smooth, or rarely minutely granular, 9—21 × 8—12 μ; promycelium cylindrical, 3-septate, promycelium spores produced laterally on the promycelium in numbers, elliptical, conjugating in pairs.

Syn. *Uredo hydropiperis,* Schum.
Ustilago hydropiperis, Schroet.
Ustilago candollei, Tul.

In the ovary of *Polygonum hydropiper, P. persicaria, P. viviparum, P. mite.*

France, Italy, Germany, Finland, N. and S. America.

DOASSANSIA, Cornu

Spores produced in dense clusters, enclosed by a receptacle formed of sterile cells of the mycelium, wall smooth; germination by the production of a promycelium as in *Entyloma.*

The present genus agrees with *Sphacelotheca* in having the spores enclosed in a special receptacle formed of mycelium, but differs in the absence of a columella, and in the different mode of origin of the promycelium spores. The receptacle is composed of a row of cells closely packed side by side, like the palisade tissue of a leaf.

Doassansia alismatis, Cornu; Plowr., *Ured.*, p. 294.

Sori forming large yellowish-brown pustules on both sides of the leaves, often numerous, sometimes growing into each other or arranged in circles, on pale yellowish spots; spore-balls numerous; spores subglobose, 9—14 μ, wall thin, smooth, tinged yellow, investing membrane of the spore-mass brown; promycelium spores long, cylindrical, numerous at the tip of the promycelium.

Syn. *Uredo alsinacearum,* Crouan.
Entyloma alsinacearum, Sacc.

On *Alisma plantago.* Often in company with *Cylindrosporium alismacearum,* with which it may be genetically connected.

Europe generally, S. Siberia, and United States.

Doassansia sagittariae, Fischer; Plowr., *Ured.*, p. 295.

Sori forming yellowish-brown pustules on the under

surface of the leaves, rather large, more or less circular, often encroaching on each other, on pale yellow spots; spores irregularly globose, wall thickish, 9—14 μ; promycelium spores similar to those of *D. alismatis*.

Syn. *Uredo sagittariae*, West.
Physoderma sagittariae, Fuckel.
Protomyces sagittariae, Fuckel.
Protomyces bizzozerianus, Sacc.

On leaves of *Sagittaria sagittifolia*.

France, Germany, Italy, Belgium, N. and S. America.

Doassansia comari, De Toni and Mass.

Sori gregarious or scattered, blackish when dry, rather small; spores broadly elliptical, smooth, pale brown with a violet tinge, 10 × 7 μ, general receptacle enclosing the spore-mass well developed, brown.

Syn. *Protomyces comari*, Berk.

On leaves of *Comarum palustre*.

Forming gregarious or scattered, usually elongated, pustules on both surfaces of the leaves.

TUBURCINIA, Fries.

Sori flattened or slightly swollen, black, often large; spores aggregated in clusters; germination by the protrusion of a slender promycelium producing promycelium spores as in *Entyloma*. Conidiophore stage forming expanded white tufts on the leaves.

Resembling *Sorosporium* in having the spores in dense clusters, differing in the absence of a gelatinous investment surrounding the spore-masses.

Tuburcinia trientalis, Berk. and Broome; Plowr., *Ured.*, p. 293.

Spore-masses forming black, swollen spots on the stem and leaves; spore-clusters irregular in form, containing from 50—100 spores; spores globose or elliptical or more or less flattened from mutual pressure, 15—32 × 10—17 μ, wall smooth, dusky brown; promycelium spores numerous, produced at the tip of the promycelium, cylindric spindle-shaped, conjugating near the base, and afterwards producing secondary spores; conidia elliptical or more or less pear-shaped, colourless.

Syn. *Ascomyces trientalis*, Berk.
Sorosporium trientalis, Wor.

On *Trientalis europaea*, *Paris quadrifolia*.

Forming crust-like expansions on the stem, and rounded

spots on the leaves. Conidial stage forming white, spreading patches on the under surface of the leaves. Conidiophores erect, slender.

THECAPHORA, Fingerh.

Spore-balls formed of several firmly-adherent cells, spore-forming hyphae not gelatinising; promycelium slender, sometimes branched; promycelium spores slender, spindle-shaped, produced singly at the tip of the promycelium.

Resembling *Sorosporium* in having all the spores forming the spore-balls fertile, but in the present genus the component spores are comparatively large, few in number, and firmly adherent to each other, the free side of each being convex, the sides in contact, flat, whereas in *Sorosporium* the spores forming a spore-ball are numerous, globose, and small, and fall easily apart.

Thecaphora hyalina, Fingerh.; Plowr., *Ured.*, p. 200.

Spore-masses produced in the seeds, pale reddish-brown, coarsely powdery; spore-balls of 3—10 spores, spores globose, 12—15 μ, pale brown, free surface of each densely and minutely warted, promycelium branched, promycelium spores unknown.

Syn. *Uredo seminis-convolvuli*, Desm.
Ustilago capsularum, Fr.
Sorosporium hyalinum, Wint.

In the fruit of *Convolvulus sepium*, *C. arvensis*, *C. soldanella*.

Thecaphora trailii, Cooke; Plowr., *Ured.*, p. 296.

Spore-balls forming a purplish-brown powdery mass in the inflorescence; 2—4 spores in a spore-ball, spores subglobose or more or less compressed at the points of contact, wall with a very small, delicate network, 12—16 μ.

On the inflorescence of *Carduus heterophyllus*.

Cooke says the fungus is pulverulent, having very much the habit of *Ustilago cardui*, but differs in being a true *Thecaphora*, and in the epispore being verrucose and not reticulate. An examination of the type specimens shows that the epispore is reticulated or covered with a network, and not warted. The nature of the promycelium can alone settle its true position.

CINTRACTIA, Cornu

Spores adhering in masses forming spore-balls, becoming free at maturity; germination ?

Closely resembling *Ustilago* in habit and in the small size of the spores, differing in the coarsely granular nature of the powder, due to the spores being aggregated in masses at first and bound by a subgelatinous substance, finally becoming free. The species were at one time included in *Ustilago*.

Cintractia patagonica, Cke. and Mass.

Sori produced in the ovary and glumes, black, not becoming pulverulent; spores dark brown, globose or subglobose, smooth, averaging 5 μ, at first in dense clusters or spore-balls.

On *Bromus unioloides* and *Festuca bromoides*.

This species was founded on material received at Kew, from Patagonia. Some time afterwards an English traveller in South America observed that *Bromus unioloides* was grown mixed with lucerne, for fodder. Seed of this grass was brought home, sown, and in due course produced not only fruit, but also its parasite, *C. patagonica*, which was received at Kew a second time for identification.

SOROSPORIUM, Rud.

Spore-balls formed of numerous, small, globose spores of equal size, which separate readily, produced from gelatinised hyphae, and at first covered by a gelatinous investment; promycelium slender, promycelium spores unknown.

Readily known by the dense spore-balls of equal size, and all capable of germination. The true position must remain uncertain until the mode of germination is known.

Sorosporium saponariae, Rud.; Plowr., *Ured.*, p. 296.

Spore-balls forming a pale reddish-brown, coarsely powdery mass in the inflorescence; spores subglobose or broadly elliptical, pale ochraceous, pellucid, the free surfaces with minute warts or ridges, 12—18 × 10—14 μ; promycelium slender.

Syn. *Thecaphora tunicae*, Auersw.
Schizoderma saponariae, Fries.

In the ovary, filaments of stamens, etc., of *Saponaria officinalis, Dianthus deltoides, Lychnis dioica, Stellaria holostea*.

Germany, Austria, France, Italy, and Algeria.

Sorosporium scabies, Fischer (=*Tuburcinia scabies*, Berk.; Plowr., *Ured.*, p. 294), has been shown to belong to the Myxogastres or Mycetozoa, and is now known as *Spongospora scabies*, Mass.

UROCYSTIS, Rabenh.

Forming coarsely powdery blackish sori at maturity, which burst through the epidermis; spores in inseparable clusters, one or several thick-walled, dark coloured spores, surrounded by thin-walled, colourless, sterile cells; germination by a promycelium bearing slender promycelium spores at the tip.

Distinguished by the peculiar character of the spores, commonly called "spore-balls." The dark-coloured central cells are alone capable of germinating.

Urocystis occulta, Rabenh.; Plowr., *Ured.*, p. 285.

Sori forming long black streaks on stem, leaves and leaf-sheaths; spore-balls globose or elliptical, formed of 1—3 dark, central, fertile spores, smooth, 10—18 μ, surrounding sterile cells pale coloured.

Syn. *Uredo parallela,* Berk.
Uredo occulta, Rabenh.
Polycystis parallela, Berk. and Broome.

On Rye—*Secale cereale*; Barley—*Hordeum vulgare, Arrhenatherum elatior, Lolium perenne, Triticum vulgare, Alopecurus agrestis, Poa pratensis.*

Germany, France, Belgium, and United States.

Urocystis agropyri, Schroet.; Plowr., *Ured.*, p. 285.

Sori forming long black lines on the leaves; spore-balls subglobose, 1—3 dark-walled fertile cells, 8—12 μ, surrounded by a few colourless sterile cells.

Syn. *Urocystis parallela,* Berk. and Broome.
Urocystis fischeri, Korn; Plowr., *Ured.*, p. 286.

On *Triticum repens, Arrhenatherum elatior, Festuca rubra, Bromus inermis, Carex acuta, C. glauca, C. muricata.*

Germany.

Urocystis colchici, Rabenh.; Plowr., *Ured.*, p. 286.

Forming large black streaks and patches on the leaves, which soon rupture the epidermis and become powdery; spore-balls globose or oblong, fertile dark-coloured central spores 2—4, 10—15 μ, sterile peripheral cells rather thick-walled, two layers sometimes present, yellowish-brown.

Syn. *Uredo colchici,* Link.
Polycystis colchici, Strauss.

On *Colchicum autumnale, Muscari racemosa, Paris quadrifolia.*

Italy, Belgium, and Germany.

Urocystis sorosporoides, Korn.; Plowr., *Ured.*, p. 287.

Forming swollen pustules on the leaves, and elongated

on the stem, at first covered by the epidermis, then exposed and powdery, black ; spore-balls subglobose, 4—6 central, dark-celled fertile spores, 11—17 μ, outer sterile cells numerous, pale yellowish-brown.

On *Thalictrum minus*.

Germany.

Urocystis gladioli, W. G. Smith ; Plowr., *Ured.*, p. 287.

Spore-masses forming raised patches on the corm, at first covered, then bursting through, black ; spore-balls subglobose, dark-walled, central, fertile spores 3—6 μ, convex on the free side, flattened where in contact with each other, outer sterile cells numerous, pale brown.

Syn. *Uredo gladioli,* Reg.

On corms of *Gladiolus communis*.

France and Germany.

Urocystis anemones, Schroet. ; Plowr., *Ured.*, p. 288.

Sori forming large, convex patches on leaves and stems, at first covered by the epidermis, then bursting through, black ; spore-balls variable in size and form, dark-walled, central fertile cells 1—2, rarely more, 16—18 μ ; outer sterile cells pale brown, completely surrounding the central ones.

Syn. *Uredo ranunculacearum*, D.C.
Uredo pomphologodes, Lév.
Polycystis pomphologodes, Rabenh.

On *Anemone nemorosa, Anemone coronaria, Hepatica triloba, Actaea spicata, Ficaria ranunculoides, Ranunculus bulbosus, R. repens*.

Europe generally, Asiatic Siberia, United States.

Urocystis violae, Fischer ; Plowr., *Ured.*, p. 288.

Spore-masses forming rather large swellings on the leaves and leaf-stalks ; spore-masses subglobose or elliptical, central, dark-walled, fertile spores 1—7 sometimes more, 15—24 × 10—15 μ, outer sterile cells hemispherical, numerous, pale brown.

Syn. *Granularia violae*, Sow.
Polycystis violae, Berk. and Broome.

On *Viola hirta, V. odorata, V. silvatica, V. tricolor*.

Italy, France, and Germany.

Urocystis primulicola, Magnus ; Plowr., *Ured.*, p. 289.

Spore-masses blackish-brown, produced in the ovary, becoming powdery ; spore-balls subglobose or irregular in form, dark-walled fertile cells 2—6, sometimes more, 9—15 μ, sterile cells very numerous, small.

On *Primula vulgaris* and *P. farinosa*.

Germany and Italy.

ADDENDA

Phytophthora erythroseptica, Pethybridge.

Mycelium branched, becoming septate with age ; conidia egg-shaped, produced sympodially, 20 × 32 μ ; antheridia terminal, lateral or intercalary, subglobose or egg-shaped, penetrated at or near the base by the young oogonium, which passes through the antheridium and forms a pear-shaped body, which eventually contains a single globose oospore with a thick, brownish wall, 29—30 μ diam.

This parasite causes potato tubers to rot quickly. The cut surface of an infected tuber quickly turns pink, on exposure to the air, and later becomes almost black. The disease is popularly designated as Pink rot, and is the cause of serious injury to the potato in some parts of Ireland.

Judging from the account given, this appears to be a very remarkable fungus, but as there are many gaps to be filled up by further research, the startling suggestions made may be to some extent modified eventually. As to whether the conidia produce zoospores or a germ-tube on germination is not known, although it is stated that attempts were made to promote germination, by stimulation with oxygen gas. But it is the mode of development of an apparently sexually formed oospore, by the penetration of the female organ through the substance of the male organ or antheridium, that renders this fungus, so far as its author can ascertain, quite unique amongst fungi. Long may it remain so. The cytological side of the question has not been studied, hence it is perhaps somewhat premature on the part of the author to suggest the establishment of a new family for the inclusion of fungi presenting characters, the significance of which is not understood.

The paper dealing with this fungus is in *The Scient. Proc. Roy. Dublin Soc.*, March, 1913.

This species should follow *Phytophthora infestans*, De Bary.

Phytopthora infestans, De Bary.

It is now generally admitted that this fungus does not produce oospores or resting-spores in a state of nature, but that for some unknown reason, probably owing to having resting mycelium present in the tubers of its host-plant, this stage has been suppressed as superfluous. Quite recently Clinton, an American mycologist, has succeeded in producing oogonia and antheridia of this fungus in pure cultures, oospores were present in the oospheres, but no evidence of fertilisation was observed, and no germination of the oospores resulted. *Science*, N.S., 33, p. 744 (1911).

Pethybridge and Murray have corroborated Clinton's observations, and added some important points; from their cultures it appears that the oogonium penetrates and grows through the antheridium as in *Phytophthora erythroseptica*, described above. No germination of oospores has been observed, and if fertilisation occurs, it must precede the formation of the oosphere. a point hitherto unknown in the *Peronosporaceae*.

Scient. Proc. Roy. Dublin Soc., March, 1913.

Peronospora potentillae, De Bary.

Tufts more or less dense, sometimes softish, at first whitish then greyish-brown or dingy violet; conidiophores slender, densely tufted, 300—600 × 7—8 μ, 5—6 times branched above, the lower and median branches spreading, forming acute angles, ultimate and penultimate branches spreading, tips often recurved; conidia elliptical, 20—25 × 15—18 μ, tinged violet; oospore with a smooth, yellowish wall.

Syn. *Peronospora rubi*, Rab.
Peronospora fragariae, Roze and Cornu.

On leaves of *Potentilla anserina, P. argentea, P. fragariastri, Alchemilla vulgaris, Sanguisorba eupatoria, Fragaria vesca, Rubus caesius, Rubus fruticosus, Poterium sanguisorba.*

Britain, Europe generally, N. America.

This species is included in the body of the book by mistake, as not having occurred in Britain.

Uromyces lilii, Fuckel.

Pycnidia. Yellowish-brown, mixed with the aecidia.

Aecidia. Occurring on both surfaces of the leaf, most frequently on the under surface, also on the petioles and stem, on yellowish or brownish-yellow spots, in roundish

or elongated groups of various sizes, often broadly extended and more or less densely arranged, remaining for a long time closed, then opening by a pore, but scarcely becoming cup-shaped, edge not recurved, large, about 1 mm. diam., yellow; spores angularly globose, densely and minutely warted, yellowish, 22—35 × 20—26 μ, epispore 3—3.5 μ thick.

Teleutospores. Sori on both surfaces of the leaves, most frequent on the upper side, scattered, or in more or less dense clusters, circular or oblong, often elongated when growing on the leafstalks, covered at first by the epidermis, powdery, dusky brown; spores globose, subglobose, elliptical, oblong or pear-shaped, tip rounded, with a slightly prominent hyaline papilla, wall brown, with somewhat indistinct warts arranged in broken lines, 28—44 × 20—30 μ, epispore 2—3.5 μ thick, pedicel colourless, slender, deciduous.

On leaves, leafstalks and stem of cultivated species of *Lilium* and *Fritillaria*.

Britain and Europe generally.

Recently recorded as occurring on *Lilium candidum*, in the country, by Mr. Grove.

Puccinia zopfii, Winter.

Aecidia. On the under surface of the leaf, on pale, circular spots, arranged in minute groups, also forming long clusters on the leafstalks; cup-shaped, edge recurved, torn, whitish; spores angularly globose, very minutely warted, orange, 20—30 μ.

Uredospores. Sori on small pale or brown spots, generally on the under surface of the leaf, scattered, minute, soon naked, chestnut colour; spores globose, subglobose or ellipsoid, minutely spiny, brownish, 22—30 × 20—25 μ

Teleutospores. Sori irregularly scattered on both sides of the leaf, minute, soon naked, blackish-brown; spores elliptical or oblong, ends rounded, tip with a slightly thickened broad and flattened paler wart, scarcely at all, or slightly constricted at the septum, very minutely warted brown, 35—60 × 20—35 μ, pedicel colourless, short, soon falling away.

Syn. *Puccinia calthaecola*, Schroeter.

On living leaves of Marsh marigold—*Caltha palustris*.

Recently recorded as occurring in this country by Mr. Grove. Europe generally.

In the specimens that I have examined in Fuckel, *Fung. Rhen.*, 370 ; Syd. *Ured.*, 168 ; and Oud. *Fung. Neerl.*, 133, the teleutospores are practically smooth, traces of warts being only visible under special treatment and manipulation. *P. calthae* is distinguished by the completely smooth teleutospores having a conical wart at the tip.

Puccinia simplex, Eriksson and Hemmings.

Uredospores. On both surfaces of the leaves, minute, scattered, dot-like, yellow ; spores globose or elliptical, spinulose, yellow, 19—22 μ, or 22—27 × 15—20 μ.

Teleutospores. Sori on both sides of the leaves, also often on the culm, minute, scattered and dot-like on the leaves, larger on the culm, generally crowded into each other, oblong, covered by the epidermis, black ; spores oblong-clavate or clavate, tip rounded or obliquely conically narrowed, thickened up to 4—8 μ, smooth, brown, 40—54 × 15—24 μ, pedicel tinged brown, short.

Mesospores. Generally very numerous, unsymmetrical, oblong or somewhat club-shaped, variable, tip thickened up to 4—10 μ, 25—45 × 16—24 μ ; paraphyses brown, tip thickened.

Syn. *Puccinia straminis,* Fuckel, var. *simplex,* Koern.
Puccinia rubigo-vera, var. *simplex,* Schroeter.
Puccinia anomala, Rost.
Uromyces hordei, Niels.
Uredo simplex, Eriksson and Henn.

On barley—*Hordeum distichum,* and other species of Hordeum. Found in abundance in a barley field at Lynsted. Europe generally and Asia Minor.

Characterised by the presence of numerous mesospores.

INDEX OF GENERA AND SPECIES

	Page
Aecidium adoxae ...	110
,, *albescens* ...	110
,, *allii*	154
,, *allii-ursini* ...	154
,, *aquilegiae* ...	150
,, *asperifolii*	148, 149
,, *aviculare* ...	82
,, *behenis*	80, 134
,, *berberidis* ...	145
,, bunii	118
,, *calthae* ...	133
,, *clematidis* ...	138
,, *compositarum*	142, 157
,, *confertum* ...	85
,, *convallariae* ...	154
,, *crassum* ...	146
,, *crassum*, var. *ficariae* ...	85
,, *crassum*, var. *periclymeni*	152
,, *depauperans* ...	126
,, euphorbiae	94, 168
,, epilobii ...	125
,, *frangulae* ...	146
,, gentianae ...	116
,, glaucis	84, 168
,, *grevillei* ...	108
,, *grossulariae* ...	132
,, *jacobaeae* ...	142
,, *laceratum* ...	171
,, leucospermum	167
,, *melampyri* ...	153
,, *menthae* ...	113
,, mespili ...	172
,, *nymphoides* ...	145
,, *orchidearum* ...	154
,, *parnassiae* ...	144
,, *pedicularis* ...	144
,, *periclymeni* ...	152
,, phillyreae ...	167
,, *pini*	179
,, poterii ...	167
,, pseudo-columnare	168
,, *prenanthis*	104, 105
,, primulae ...	116
,, *ranuncylacearum*	85, 150, 155

	Page
Aecidium ranunculacearum var. *thalictri*	158
,, *ranunculacearum*, var. clematidis	158
,, *ranunculi-acris*	150
,, *rhamni* ...	146
,, *rubellum* ...	156
,, saniculae ...	123
,, *scrophulariae* ...	72
,, *taraxacum* ...	108
,, *thesii*	137
,, *tragopogi* ...	109
,, *tussilaginis* ...	157
,, *valerianearum*...	72
,, violae	126
,, *zonale*	83
Alphitomorpha tridactyla	39
Aregma gracile	175
,, *mucronatum* ...	174
Artotrogus hydnosporus ...	9
Ascomyces trientalis ...	201
Basidiophora	15
,, entospora ...	15
Botrytis arborescens ...	31
,, *arenariae* ...	29
,, *destructor*... ...	28
,, *effusa*	32
,, *ganglioniformis* ...	21
,, *grisea*	31
,, *infestans*	14
,, *lactucae*	21
,, *nivea*	20
,, *parasitica* ...	28
,, *viticola*	19
,, *viciae*	21
Bremia	21
,, *lactucae*	21
Caeoma armeriae	73
,, *bistortarum* ...	193
,, *obtegens*	100
,, *olivaceum* ...	188
,, *orchidis*	91
,, *rumicis*	156
,, *suaveolens* ...	100
,, *veronicae* ...	112
,, violaceum ...	190

	Page
Caeoma zeae	189
Calyptospora	177
,, goeppertiana	177
Capnodium	51
,, elongatum ...	52
,, footii ...	52
,, salicinum ...	51
Cintractia	202
,, patagonica ...	203
Coleosporium	179
,, campanulae	180
,, euphrasiae ...	180
,, *rhinantheaceae-arum* ...	181
,, senecionis ...	179
,, *senecionis* ...	179
,, sonchi ...	180
,, *tussilaginis* ...	180
Cronartium	92
,, flaccidum ...	93
,, *paeoniae* ...	93
,, ribicolum ...	93
Cystopus	10
,, *amaranthacearum*	12
,, *amaranthi* ...	12
,, bliti	12
,, bliti	11
,, brasiliensis ...	10
,, candidus ...	11
,, candidus, *var.* convolvuli ...	11
,, *convolvulacearum*	11
,, convolulacearum	10
,, *cubicus*	13
,, euphorbiae ...	10
,, lepigoni ...	12
,, portulacae ...	12
,, statae	10
,, *spinulosus* ...	13
,, tilleae	11
,, tragopogonis ...	12
,, tropicus... ...	10
Cytosiphon pythioides ...	9
Dicaeoma buxi	128
Doassansia	200
,, alismatis ...	200
,, comari ...	201
,, sagittariae ...	200
Endophyllum	93
,, *euphorbiae*...	94
,, euphorbiae-silvaticae	94
,, sempervivi	93
Entorrhiza	199

	Page
Entorrhiza aschersoniana	199
,, *cypericola* ...	199
Entyloma	196
,, *alsinacearum*	200
,, bicolor ...	197
,, calendulae ...	198
,, *canescens* ...	197
,, chryosospleni	198
,, fergussoni ...	197
,, *matricariae* ...	198
,, microsporum	198
,, ranunculis ...	197
,, trailii ...	197
,, *ungerianum*	198
Erysible longissima ...	192
,, *olivaceae* ...	188
Erysiphe	47
,, *aduncа*	43
,, cichoracearum ...	48
,, *communis* ...	49
,, gaelopsidis ...	48
,, graminis ...	48
,, *guttata*	47
,, *lamprocarpa* ...	48
,, *Linkii*	48
,, *martii*	49
,, *montagnei* ...	48
,, *mors-uvae* ...	42
,, *oxycanthae* ...	39
,, *penicillata* ...	44
,, polygoni ...	49
,, tortilis	49
,, *trifolii*	49
,, *tuckeri*	44
Farinaria scabiosae ...	191
,, *stellariae* ...	190
Fumago fagi	52
,, *vagans*	51
Gloeosporium ficariae ...	197
Granularia violae ...	126
,, *violae* ...	205
Gymnosporangium ...	171
,, clavariaeforme	171
,, confusum ...	172
,, juniperinum ...	172
,, sabinae	171
Hemileia	170
,, americana ...	170
,, *oncidii*	170
Lecythea lini	92
,, *poterii*	177
,, *ruborum* ...	173
,, *valerianae* ...	72

	Page
Melampsora	91
,, lini	92
,, pinitorqua ...	92
,, repentis ...	91
Melanotaenium	198
,, endogenum	199
Microsphaera	44
,, alni ...	45
,, astragali ...	45
,, baumleri ...	46
,, berberidis	44
,, *comata* ...	45
,, euonymi ...	45
,, grossulariae	46
,, *hedwigii* ...	45
,, *holosericea*	45
,, *lycii* ...	46
,, *marchica* ...	46
,, mougeotii ...	46
,, *penicillata*	45
Milesia	49
,, polypodii ...	94
Milowia nivea	51
Peridermium pini ...	179
,, *strobi* ...	93
Peronospora	21
,, affinis ...	33
,, alsinearum ...	30
,, alta	34
,, antirrhini ...	26
,, arborescens...	31
,, arenariae ...	29
,, arthuri ...	25
,, *asperuginis*	32
,, borreriae ...	23
,, *cactorum* ...	14
,, *calaminthae*...	33
,, calotheca ...	29
,, candida ...	26
,, *chenopodii* ...	32
,, chrysosplenii	25
,, claytoniae ...	24
,, *conferta* ...29,	30
,, *conferta*, var. *agrostemmatis*	29
,, conglomerata	26
,, corollae ...	23
,, corydalis ...	27
,, cytisi ...	24
,, *cynoglossi* ...	32
,, cyparissiae ...	24
,, *densa* ...	19
,, *destructor* ...	28
,, dianthi ...	28

	Page
Peronospora dipsaci ...	24
,, dubia ...	23
,, effusa ...	32
,, *effusa*, var. *violae* ...	31
,, eranthidis ...	26
,, euphorbiae	24
,, *fagi*	14
,, ficariae ...	34
,, *fragariae* ...	207
,, galii ...	30
,, *ganglioniformis*	21
,, gonolobi ...	23
,, grisea 31,	34
,, *grisea* var. *tripolii* ...	31
,, hedeomatis	25
,, holostei ...	25
,, hydrophylli	25
,, *obovata* ...	30
,, *papaveris* ...	31
,, *radii* ...	23
,, lamii ...	33
,, lapponica ...	26
,, *lepigoni* ...	30
,, leptosperma	23
,, linariae ...	26
,, lini	23
,, lophanthi ...	24
,, megasperma	23
,, myosotidis ...	32
,, *myosuri* ...	34
,, niessleana ...	27
,, *nivea* 19,	20
,, oxybaphi ...	25
,, phlogina ...	26
,, phyteumatis	24
,, polygoni ...	29
,, potentillae 25,	207
,, pulveraceae	25
,, *pusilla* ...	19
,, *pygmaea* ...	18
,, rumicis ...	28
,, *rubi*	207
,, schachtii ...	28
,, schleideni ...	28
,, *scleranthi* ...	30
,, *sempervivi* ...	14
,, *sherardiae* ...	30
,, sordida ...	33
,, sparsa ...	34
,, *sphaeroides* ...	31
,, thesii ...	27
,, *tomentosa* ...	30

		Page
Peronospora	tribulina ...	27
,,	trichotoma	25
,,	trifoliorum ...	30
,,	*umbelliferarum*	20
,,	urticae ...	34
,,	valerianae ...	27
,,	valerianellae	24
,,	viciae ...	32
,,	vincae ...	24
,,	violacea ...	27
,,	violae ...	31
,,	*viticola* ...	19
,,	whippleae ...	23
Phragmidium	... ...	173
,,	*asperum* ...	173
,,	*bullatum* ...	174
,,	*bulbosum* ...	174
,,	*carbonarium*	177
,,	*fragariastri*	176
,,	fragariastri	175
,,	*fusiforme* ...	175
,,	*gracile* ...	175
,,	*incrassatum*	174
,,	*mucronatum*	174
,,	*obusatum* ...	176
,,	*potentillae* ...	176
,,	rosae-alpinae	175
,,	rubi	174
,,	rubi idaei ...	175
,,	*sagittariae* ...	201
,,	*sanguisorbae*	176
,,	subcorticatum	174
,,	*tormentillae*	176
,,	violaceum ...	173
Phyllactinia	... ...	47
,,	corylea ...	47
,,	*guttata* ...	47
Phytophthora	... ...	13
,,	erythroseptica	206
,,	infestans	14, 207
,,	omnivora	14
,,	nicotianae	14
,,	phaseoli ...	13
Plasmopara	... ...	17
,,	australis ...	18
,,	celtidis ...	18
,,	densa ...	19
,,	*entospora* ...	16
,,	epilobii ...	18
,,	geranii ...	17
,,	halstedii ...	18
,,	heliocarpi ...	18
,,	impatientis	17

		Page
Plasmopara	nivea ...	20
,,	obducens ...	18
,,	pusilla ...	18
,,	pygmaea ...	18
,,	ribicola ...	18
,,	viticola ...	19
Podisoma juniperi	...	171
Podosphaera	... ...	38
,,	*clandestina* ...	39
,,	*grossulariae* ...	46
,,	*kunzei* ...	39
,,	leucotricha	40
,,	*myrtillina* ...	39
,,	oxycanthae ...	39
,,	oxycanthae, *var.* tridactyla	39
,,	*pannosa* ...	41
,,	*schlechtendalii*	40
Polyactis holci	... ...	195
,,	*parallella* ...	204
,,	*pomphologodes* ...	205
,,	*violae*	205
Polycystis colchici	...	204
Protomyces bizzozerianus	...	201
,,	*calendulae* ...	198
,,	*chrysosplenii*	198
,,	*comari* ...	201
,,	*endogenus* ...	199
,,	*fergussoni* ...	197
,,	*galii*	199
,,	*microsporus* ...	198
,,	*reticulatus* ...	33
,,	*sagittariae* ...	201
Puccinia	... ...	95
,,	absinthii ...	96
,,	acetosae ...	136
,,	actaeae-agropyri	166
,,	*acuminata* ...	111
,,	adoxae	109
,,	*adoxae*	110
,,	aegopodii ...	117
,,	aegra	126
,,	agropyri ...	157
,,	agropyrinum ...	164
,,	agrostidis ...	149
,,	*alpescens* ...	110
,,	allii	162
,,	ambigua ...	111
,,	*amphibii* ...	135
,,	andersonii ...	101
,,	*anomala*, ...	209
,,	angelicae ...	117
,,	annularis ...	113
,,	anthoxanthi ...	150

		Page
Puccinia	apii	118
,,	*aquilegiae* ...	150
,,	argentata ...	127
,,	*ari*	155
,,	*ari-phalaridis* ...	155
,,	artemisiella ...	159
,,	arenariae ...	133
,,	arenariicola ...	142
,,	*arenariae* ...	134
,,	arrhenatheri ...	151
,,	arundinaceae ...	156
,,	asarina	136
,,	asparagi ...	139
,,	asteris	96
,,	bardanae ...	104
,,	baryi	151
,,	berkeleyi ...	115
,,	betonicae ...	112
,,	bistortae ...	135
,,	*blytii*	129
,,	blyttiana ...	161
,,	borealis ...	164
,,	*brachypoda* ...	152
,,	bromina ...	148
,,	*buchanani* ...	135
,,	bulbocastani ...	118
,,	bullata ...	121, 122
,,	bunii	118
,,	bupleuri-falcati	119
,,	buxi	127
,,	calthae	132
,,	*calthaecola* ...	208
,,	campanulae ...	109
,,	*cardui*	101
,,	cardui-pycnocephali	97
,,	carduorum ...	96
,,	caricis	141
,,	*caricina* ...	141
,,	carlinae ...	97
,,	*caryophyllarum*, var. *spergulae*	134
,,	caulinicola ...	114
,,	centaureae ...	98
,,	cerasi	161
,,	chaerophylli ...	119
,,	*chondrillae* ...	104
,,	chrysanthemi ...	99
,,	chrysosplenii ...	130
,,	cichoria ...	99
,,	circaeae ...	124
,,	cirsii	101
,,	cirsii-lanceolati	159
,,	clinopodii ...	113
Puccinia	cnici-oleracei ...	101
,,	convolvuli ...	114
,,	conii	120
,,	coronata ...	146
,,	crepidis, Schroeter	159
,,	*cruciati*	111
,,	cyani	98
,,	cynodontis ...	165
,,	depauperans ...	126
,,	*difformis* ...	111
,,	*digrapidis* ...	154
,,	dioicae	141
,,	dispersa... ...	148
,,	*elymi*	179
,,	epilobii	125
,,	epilobii-tetragoni	125
,,	expansa... ...	106
,,	extensicola ...	143
,,	*fallens*	77
,,	fergussoni ...	127
,,	festucae... ...	152
,,	fusca	132
,,	galanthi ...	162
,,	*galii*	111
,,	*galiorum* ...	111
,,	gentianae ...	115
,,	geranii silvatici	161
,,	gigantea ...	160
,,	glechomatis ...	112
,,	glomerata ...	106
,,	*glomerata* ...	179
,,	glumarum ...	147
,,	graminis ...	145
,,	*graminis*	145, 155
,,	*gracilis*	175
,,	helianthi ...	102
,,	heraclei ...	120
,,	hieracii	103
,,	holboelli ...	161
,,	holcina ...	164
,,	hydrocotyles ...	121
,,	hypochoeridis ...	103
,,	*hysterium* ...	109
,,	*inquinans*, var. *tragopogonis* ...	109
,,	*intermixta* ...	154
,,	intybi	102
,,	iridis	137
,,	junci	163
,,	karsteni... ...	160
,,	lampsanae ...	104
,,	*lappae*	105
,,	*lapsanae* ...	102
,,	le mourieriana	159

		Page
Puccinia	leontodonis ...	105
,,	leucanthemi ...	160
,,	liliacearum ...	139
,,	*limonii*	73
,,	*linearis*	154
,,	lolii	147
,,	*lychnidearum*	133, 134
,,	*magelhaenica* ...	151
,,	magnusiana ...	156
,,	major	101
,,	malvacearum ...	128
,,	mammillata ...	162
,,	menthae ...	113
,,	milii	165
,,	millefolii ...	95
,,	*moehringiae* ...	133
,,	moliniae ...	153
,,	morthieri ...	161
,,	*neglecta*	147
,,	*nemoralis* ...	153
,,	nidificans ...	127
,,	noli-tangeris ...	127
,,	oblongata ...	140
,,	obscura ...	140
,,	obtegens ...	100
,,	obtusata ...	166
,,	opizii	163
,,	orchidearum-phalaridis ...	154
,,	oxyriae	134
,,	paliformis ...	152
,,	paludosa ...	143
,,	*paridis*	154
,,	pazschkei ...	131
,,	perplexans ...	150
,,	*perplexans*, var. *arrhenatheri* ...	151
,,	persistens ...	158
,,	petroselini ...	121
,,	phalaridis ...	155
,,	*phaseoli*, var. *taraxici* ...	108
,,	phlei-pratensis ...	166
,,	phragmitis ...	156
,,	pimpinellae ...	120, 121, 123
,,	plantaginis ...	160
,,	poarum ...	157
,,	*poculiformis* ...	145
,,	*polygoni* ...	135
,,	polygoni-amphibii	135
,,	*polygonorum* ...	135
,,	porri	138
,,	prenanthis ...	103

		Page
Puccinia	*prenanthis* ...	105
,,	prenanthis-purpurae ...	105
,,	primulae ...	116
,,	pringsheimiana	132
,,	prostii	139
,,	*pruni*	129
,,	pruni-spinosae	128
,,	*prunorum* ...	129
,,	pucedani-parisiensis	122
,,	pulverulenta ...	125
,,	pulverulenta ...	125
,,	punctata ...	110
,,	pygmaea ...	165
,,	rhodiolae ...	129
,,	ribis	131
,,	*rubi*	174
,,	*rubigo vera*	147, 148
,,	*rubigo vera*, var. *simplex* ...	209
,,	saniculae ...	123
,,	saxifragae ...	130
,,	schneideri ...	114
,,	schoeleriana ...	142
,,	schroeteri ...	138
,,	schroeteriana ...	163
,,	*scillarum* ...	83
,,	scirpi	144
,,	*scrophulariae* ...	72
,,	senecionis ...	106
,,	sessilis	153
,,	*sessilis*	154
,,	silenes	134
,,	silvatica ...	163
,,	simplex, ...	209
,,	smyrnii	124
,,	smyrnii-olusatri	123
,,	soldanellae ...	116
,,	sonchi	107
,,	*sparsa*	109
,,	spergulae ...	134
,,	*spireae*	182
,,	*straminis*	148, 209
,,	*striola*	141
,,	*suaveolens* ...	100
,,	*suaveolens, forma cyani* ...	98
,,	tanaceti... ...	107
,,	taraxici ...	108
,,	thalictri ...	133
,,	thesii	136
,,	tragopogi ...	109
,,	trailii	156

		Page
Puccinia	*triarticulata* ...	179
,,	*trifolii*	77
,,	*tritici*	147
,,	triticina ...	149
,,	*tripolii*	96
,,	trollii	162
,,	*truncata* ...	137
,,	*tuberculata* ...	133
,,	tumida	118
,,	*typhae*	145
,,	uliginosa ...	144
,,	*ulmariae* ...	182
,,	umbelliferarum	123
,,	umbilici... ...	130
,,	*vaginalium* ...	82
,,	valantiae ...	111
,,	variabilis ...	108
,,	*variabilis*, var. *intybi* ...	102
,,	veronicae ...	111
,,	veronicarum ...	112
,,	veronicae-anagallidis ...	160
,,	*verrucosa* ...	112
,,	vincae	115
,,	*violacea* ...	173
,,	violae	125
,,	violarum ...	126
,,	virgaureae ...	107
,,	winteriana ...	154
,,	zopfii	208
Pucciniastrum goeppertianum		177
Pythium		7
,,	artotrogus ...	9
,,	*autumnale* ...	8
,,	cytosiphon ...	9
,,	debaryanum ...	8
,,	*micracanthium* ...	9
,,	*equiseti*	8
,,	megalocanthum	9
,,	proliferum ...	8
,,	*vexans*	8
Reticularia segetum ...		189
Roestelia lacerata ...		171
Rostrupia		178
,,	elymi	178
Saprolegnia schactii ...		8
Schinzia aschersoniana ...		199
Schizoderma saponariae ...		203
Sclerospora		16
,,	graminis ...	16
,,	kriegeriana ...	16
,,	*macrospora* ...	16
,,	magnusiana ...	16

		Page
Sorosporium		203
,,	*hyalinum* ...	202
,,	saponariae ...	203
,,	*trientalis* ...	201
Sphacelotheca		199
,,	hydropiperis	200
Sphaerotheca		40
,,	*castagnei* ...	41
,,	humuli ...	41
,,	humuli, *var.* fuliginea	41
,,	*leucotricha*	40
,,	*mali* ...	40
,,	mors-uvae...	42
,,	pannosa ...	41
Thecaphora		202
,,	hyalina ...	202
,,	trailii ...	202
,,	*tunicae* ...	203
Thielavia		50
,,	basicola ...	50
Tilletia		194
,,	berkeleyi ...	196
,,	*brizae*	196
,,	*bullata*	193
,,	caries	195
,,	debaryana ...	196
,,	*decipiens* ...	196
,,	laevis	195
,,	rauwenhoffi ...	195
,,	*secalis*	196
,,	separata	195
,,	*serpens*	196
,,	*striaeformis* ...	196
,,	*striiformis* ...	193
,,	*tritici*	195
Torula basicola		51
Tremella clavariaeformis		171
Trichobasis artemisiae ...		96
,,	*betae*	81
,,	*carcina* ...	141
,,	epilobii ...	125
,,	*fallens* ...	77
,,	*geranii* ...	78
,,	*glumarum* ...	148
,,	heraclei ...	121
,,	hydrocotyles	121
,,	*iridis* ...	137
,,	*linearis* ...	145
,,	*parnassiae* ...	72
,,	petroselini ...	124
,,	*polygonorum* 82,	135
,,	primulae ...	116
,,	*rhamni* ...	129

		Page
Trichobasis scillarum	...	83
,, *senecionis*	...	179
,, vincae	...	115
Triphragmium	... ...	181
,, filipendulae		182
,, ulmariae		181
Tuberculinia	... ...	201
,, trientalis	...	201
Uncinula ...	... ...	42
,, aceris	... ...	42
,, *adunca*	... ...	43
,, *bicornis*	...	43
,, *bivonae*	... ...	43
,, clandestina	...	43
,, necator	... ...	44
,, prunastri	...	43
,, *spiralis*	...	44
,, salicis	... ...	43
,, *wallrothii*	...	43
Uredo aecidiiformis	...	121
,, aegopodii	... ...	117
,, agrimoniae	...	169
,, *alchemillae*	...	79
,, *alsinacearum*	...	200
,, angelicae	... ...	117
,, *antherarum*	...	190
,, *anythyllidis*	...	74
,, *apargiae*	... ...	105
,, *artemisiae*	...	96
,, *aurea*	... ...	174
,, *bardanae*	... ...	105
,, *betae*	... ...	81
,, betae, *var.* convolvuli	... ...	114
Uromyces ...	... ...	71
Uromyces chenopodii	...	89
,, *alliorum*	... ...	138
Uredo *betonicae*	... ...	112
,, *behenis*	... ...	134
,, *bifrons*	... ...	82
,, *bromina*	... ...	149
,, *campanulae*	...	180
,, *carbo*	... ...	189
,, *caricis*	... ...	141
,, *caries*	... ...	195
,, *colchici*	... ...	204
,, *coronata*	... ...	146
,, *crustacea*	... ...	180
,, *culmorum*	... ...	192
,, *cyani*	... ...	98
,, *effusa*	...	174, 182
,, *euphrasiae*	...	181
,, *fabae*	... ...	74
,, *ficariae*	... ...	79

		Page
Uredo *filicum*	... ...	95
,, *filipendulae*	...	182
,, *frumenti*	... ...	145
,, *gladioli*	... ...	205
,, *gyrosa*	... ...	175
,, *hydropiperis*	...	200
,, *hypodytes*	... ...	193
,, *intrusa*	... ...	79
,, *iridis*	... ...	137
,, labiatarum	...	113
,, *linearis*	...	95, 145
,, *lini*	... ...	92
,, lynchii	... ...	169
,, *melampyri*	...	181
,, *miniata*	... ...	177
,, mulleri	... ...	169
,, *oblongata*	... ...	141
,, *occulta*	... ...	204
,, *olivacea*	... ...	188
,, *parallela*	... ...	204
,, *parnassiae*	... ...	72
,, *polygonorum*	...	135
,, polypodii	...	169
,, *pomphologodes*	...	205
,, *prenanthis*	...	104
,, primulae	...	116
,, quercus	... ...	169
,, *ranunculacearum*		205
,, *receptaculorum*	...	190
,, *rhinantheacearum*	...	181
,, *rubigo-vera*	...	148
,, *rubi-idaei*	... ...	175
,, *rumicis*	... ...	82
,, *sagittariae*	...	201
,, *scillarum*	... ...	83
,, *scirpi*	... ...	145
,, scolopendri	95,	169
,, *secalis*	... ...	196
,, *segetum*	... ...	189
,, *seminis-convolvuli*		202
,, *sempervivi*	...	94
,, sepium	... ...	114
,, *simplex*	... ...	209
,, *sonchi arvensis*	...	180
,, *sparsa*	... ...	80
,, *striaeformis*	...	196
,, *suaveolens*	...	100
,, symphyti	... ...	160
,, *thesii*	... ...	137
,, *tragopogonis*	...	190
,, *triticina*	... ...	149
Uredo tropaeoli	... ...	169
,, *tussilaginis*	...	180
,, *utriculosa*	... ...	191

		Page
Uredo	*urceolarum* ...	188
,,	*veronicae*	112
,,	vincae	115
,,	*vinosa*	191
,,	*virolacea*	190
,,	violarum	126
,,	*zeae-mays*	189
Urocystis	... ...	204
,,	agropyri ...	204
,,	anemones ...	205
,,	colchici	204
,,	*fischeri*	204
,,	gladioli ... 20 and	5
,,	occulta	204
,,	*parallela* ...	204
,,	primulicola ...	205
,,	sorosporoides ...	204
,,	violae	205
Uromyces	... ...	71
,,	acetosae ...	90
,,	aconiti-lycoctoni	79
,,	alchemillae ...	78
,,	*alliorum* ...	138
,,	ambiguus ...	90
,,	anthyllidis ...	73
,,	appendiculatus	74, 75
,,	armeriae ...	73
,,	astragali ...	86
,,	behenis ...	80
,,	betae	80
,,	briardi ...	88
,,	caryophyllinus	89
,,	cervi	74
,,	*concentricus* ...	83
,,	*concomitans* ...	72
,,	croci	90
,,	dactylidis ...	84
,,	*excavatus* ...	78
,,	fabae	74
,,	festucae ...	90
,,	ficariae ...	79
,,	gageae ...	82
,,	genistae tinctoriae	86
,,	geranii ...	78
,,	heimerlianus ...	88
,,	*hordei*	209
,,	*intrusus* ...	79
,,	junci	83
,,	lilii	207
,,	limomii ...	72
,,	loti	87
,,	*maritima* ...	84
,,	melosporus ...	89

		Page
Uromyces	minor	88
,,	onobrychidis ...	87
,,	ononidis ...	87
,,	ornithogali 82,	90
,,	orobi	75
,,	*parnassiae* ...	72
,,	*phaseoli* ...	76
,,	*phaseolorum* ...	76
,,	phyteumatum	86
,,	pisi	87
,,	poae	85
,,	polygoni ...	81
,,	*polygonorum* ...	82
,,	ranunculi-festucae	91
,,	rumicis ...	82
,,	salicorniae ...	81
,,	salsolae ...	89
,,	scillarum ...	83
,,	scirpi	84
,,	scrophulariae ...	72
,,	scutellatus ...	77
,,	solidaginis ...	86
,,	sparsus ...	80
,,	striatus ...	76
,,	thapsi	86
,,	trifolii ...	76
,,	trifolii-repentis	77
,,	truncatulus ...	88
,,	tuberculatus ...	88
,,	*ulmarie* ...	182
,,	valerianae ...	71
,,	vicia-craccae ...	88
Ustilago	... ...	187
,,	*antherarum* ...	190
,,	bistortarum, *var.* glabra ...	193
,,	bistortarum ...	193
,,	bromivora ...	190
,,	*bullata*	193
,,	*candollei* ...	200
,,	*capsularum* ...	202
,,	cardui	190
,,	caricis	188
,,	*carbo*, var. *vulgaris*, d. *bromivora*	190
,,	*foetens*	195
,,	*flosculorum* ...	191
,,	grammica ...	193
,,	grandis	192
,,	hordei	188
,,	*hydropiperis* ...	200
,,	hypodytes ...	193
,,	hypogaea ...	194

		Page
Ustilago	kuhneana ...	174
,,	longissima ...	192
,,	*lygei*	193
,,	major	191
,,	marina	194
,,	maydis	189
,,	*montagnei* ...	188
,,	nuda	188
,,	olivacea... ...	188
,,	*persicariae* ...	191
,,	*purpurea* ...	190
,,	*russiana* ...	190
,,	salveii	192
,,	scabiosae ...	191
Ustilago	segetum	188, 189
,,	sorghi	189
,,	tragopogi ...	190
,,	*typhoides* ...	192
,,	*urceolarum* ...	188
,,	utriculosa ...	191
,,	vaillantii ...	192
,,	vinosa	191
,,	violacea... ...	190
,,	*zeae-mays* ...	189
Xenodochus	... ...	176
,,	carbonarius	176
,,	curtus ...	177

INDEX OF HOST-PLANTS

	Page
Abies amabalis	168
,, balsamea	178
,, cephalonica,	168, 178
,, cilicia	178
,, concolor	178
,, fraseri	178
,, magnifica	178
,, nobilis	178
,, nordmannidna	168, 178
,, pectinata ...	168, 178
,, pictita	178
,, pinsapa	178
,, vietchii	178
Abutilon	128
Acer	14, 47
,, campestre	43
,, pseudo-platanus ...	43
Achillea	...48, 49
,, millefolia ...	95
Achnida	... 12
Aconitum	18
Actaea spicata ...	166, 205
Aconitum Lycoctonum ...	79
Adiantum capillus-veneris	95
Adoxa moschatellina ...	110
Aegopodium podagraria	20, 117
Aethusa cynapium ...	122
Althaea rosea	128
Agrimonia eupatoria ...	169
Agropyrum ...	49, 146
,, glaucum ...	158
,, repens	164, 193, 196
Agrostemma	29
,, githago ...	133
Agrostis	49, 196
,, alba	85, 146, 196
,, pumila	196
,, stolonifera ...	146
,, vulgaris	146, 196
Aira	146
,, caespitosa ...	189, 193
Alchemilla alpina ...	89
,, vulgaris	79, 207
Alisma plantago	200
Allium schoenoprasum	90, 138, 162
,, carinatum ...	162

	Page
Allium cepa ...	28, 138
,, sativum	162
Alnus	45, 47
Alopecurus ...	16, 146
,, agrestis	204
,, pratensis	147, 150, 196
Amaranthus	12
Ambrosia	18
Amelanchier	39
Ampelopsis ...	20, 44
Amygdalus communis ...	129
,, persica ...	161
Anchusa arvensis... ...	148
Anemone	18
,, coronaria	129, 205
,, nemorosa	18, 132, 167, 205
,, ranunculoides	129
Angelica	47
,, archangelica ...	117
,, sylvestris	20, 160
Anthoxanthum odoratum	151, 165, 196
Anthriscus silvestris	20, 120
Anthyllis vulneraria ...	74
Apera spica-venti ...	196
Apium graveolens ...	118
Apple	40
Apocynaceae	24
Aquilegia	150
,, alpina	150
,, atrata	150
,, glandulosa ...	150
,, haenkeana ...	150
,, nigricantis ...	150
,, pyrenaica ...	150
,, sternbergii ...	150
Arabis alpina	161
,, hirsuta	161
,, petraea	161
Arctium	105
Arenaria media	12
,, serpyllifolia ...	133
Armeria alpina	73
,, maritima ...	73
,, vulgaris ...	73

	Page
Aroideae	25
Arrhenatherum	146
,, avenaceum	196
,, elatior	151, 189, 158
Artemisia	48, 96
,, vulgaris ...	159
Arum maculatum ...	15-
Arundo donax	156
Asarum europaeum ...	136
Asparagus officinalis ...	139
Asperula	49
,, odorata	30, 111
Aster	16
,, tripolium	96, 143
Astragalus ...	31, 45, 86
,, glycophyllus	45
Atriplex hastata ...	32
,, nitens	32
,, patula ...	32
,, rosea	32
Avena	146
,, elatior	158
,, fatua	147
,, flavescens ...	189, 193
,, sativa	147
Ballota	48
Barberry	146, 151
Barley ...	188, 189, 204
Bartsia	19
,, odontites... ...	181
Beech	52
Beet	28, 81
Berberis	47
,, vulgaris ...	45, 146, 157
,, (Mahonia) aquifolia	45
Beta	8
,, maritima	81
,, vulgaris ...	28, 81
Betonica officinalis ...	112
Betula	45
Bidens	18
Black currant	131
Blechnum spicant ...	95
Borreria	23
Brachypodium	146
Brachypodium silvaticium	148, 152
,, pinnatum	152, 196
Briza	146
,, media	196
Bromus	146, 149
,, arvensis	149
Bromus asper	149
,, carbo	190
,, erectus	193
,, inermis ...	196, 204
,, madritensis ...	190
,, maximus ...	149
,, mollis	178
,, secalinus ...	190
,, sterilis	149
,, uniloides	190, 203
Bulbocastanum	118
Bunium flexuosum	118, 119
Bupleurum tennuissimum	119
Buxus	47
,, sempervirens	128
Cacalia hastata	180
Cactus	14
Calamagrostis	146
,, arundinacea	146, 165
,, egpigeios	148, 165
,, halleriana	165
Calamintha clinopodium...	113
Calendula officinalis ...	198
Caltha palustris ...	133, 208
Camelina sativa	8
Campanula	48
,, rapunculus ...	109
,, rotundifolia	109, 180
,, trachelium ...	180
Campanulaceae ...	23, 24, 27
Caper	11
Capparis spinosa	11
Capsella	8, 49
,, bursa-pastoris	11
Carduus acanthoides	96, 190
,, acaulis	98
,, arvensis	100
,, crispus	96
,, heterophyllus	101, 202
,, nutans ...	96, 190
,, palustris	142
,, pycnocephalus ...	97
Carex acuta	132, 141, 204
,, alba ...	142, 163
,, ampullacea	141, 188
,, arenaria	142, 143, 188
,, binervis	141
,, dioica ...	142, 188
,, extensa	143
,, filiformis	141
,, flava	163
,, fulva	144

	Page
Carex glauca	141, 188, 204
,, goodenoughii	141, 163
,, hirta ...	141, 188
,, muricata ...	164, 204
,, oederi	163
,, paludosa	141
,, panicea ...	144, 188
,, praecox ...	141, 188
,, pseudocyperus ...	188
,, recurva	188
,, riparia ...	141, 188
,, rostrata	188
,, silvatica	163
,, stellulata	188
,, stricta	144
,, vulgaris ...	144, 188
,, vulpina	168
Caryophyllaceae	25
Cattleya dowiana ...	170
Calamintha	33
Celtis occidentatis ...	18
Centaurea	21
,, cyanea	98, 101
,, nigra ...	99, 143
Cerastium arvense ...	30
,, glomeratum ...	30
,, semidecandrum	30
,, triviale	30, 133
,, viscosum ...	191
Cereus	14
Chaerophyllum temulum	120
Chenopodium album ...	32
,, bonus-henricus ...	32
,, glaucum ...	32
,, hybridum	32
,, muralis ...	32
,, polyspermum	32
Chieranthus chieri ...	11
Chrysanthemum	99
,, leucanthemum	160
Chrysosplenium alternifolium ...	130
,, oppositifolium	130, 198
Cichorium	48
,, intybus ...	100
Cineraria	180
Circaea	49
,, lutetiana ...	124
Cirsium	21
,, acaulis	101
,, arvensis	100
Cirsium eriophorum ...	159
,, heterophyllum ...	101
,, lanceolatum	101, 159
,, palustris	159
Clarkia	14
Clematis	158
,, vitalba	158
Cleome	14
Cnicus arvensis	100
Cochlearia armoracia ...	11
Colchicum autumnale ...	204
Coltsfoot	157, 180
Comarum palustre ...	201
Compositae ...	23, 42
Conium maculatum	20, 120
Conopodium denudatum	118
Convallaria majalis ...	154
Convolvulus ...	11, 49
,, arvensis	114, 202
,, sepium	114, 202
,, soldanella ...	202
Coronilla	31
Corylus	47
Cotyledon umbilicus ...	130
Crataegus	39
,, oxyacantha	171, 172
Crepis ...	21, 48, 163
,, paludosa ...	102, 104
,, praemorsa ...	102
,, virens	159
Cress	11
Crocus biflorus	90
,, vernus	90
Cyatula	12
Cyclanthera hystrix ...	18
Cynodon	146
,, dactylis	165, 189
Cynoglossum	32
Cystopteris fragilis ...	95
Dactylis	146
,, glomerata	85, 196
Daucus carota ...	20, 84
Delphinium	49
Dianthus	29
,, armeria ...	89
,, barbatus ...	133
,, caryophyllus ...	89
,, deltoides	191, 203
Digitalis purpurea ...	33
Dipsaceae	24
Elymus	146
,, arenarius...	148, 179, 193
Epilobium	14
,, augustifolium	125 160

	Page
Epilobium hirsutum ...	125
,, montanum ...	125
,, palustris 18,	125
,, parviflorum 18,	125
,, roseum ...	125
,, tetragonum ...	125
Equisetum autumnale ...	8
Erigeron	16
Ervum hirsutum	74
Euonymus europaeus ...	45
,, verrucosus ...	45
Euphorbia amygdaloides	94
,, cyparissias 76, 86,	87
,, esula 78,	87
,, exigua 88,	168
Euphorbiacae 23,	24
Euphrasia	19
,, officinalis ...	181
Faba vulgaris	75
Fagus 14,	47
,, sylvatica	52
Fagopyrum	14
Festuca 49,	146
,, bromoides ...	203
,, elatior ... 147,	196
,, duriuscula ...	152
,, ovina 91, 152,	196
,, pratensis ...	189
Ficaria rubra 91, 152,	204
,, ranunculoides ...	205
,, ranunculus 197,	198
Forget-me-not	197
Fragaria vesca	207
Fraxinus	14
Fritillaria	208
Fumariaceae	27
Fumaria officinalis ...	33
Gagea lutea ... 82,	192
Galanthus nivalis ...	162
Galeobdolon	48
Galeopsis	48
Galium	199
,, aparine ... 30,	111
,, cruciatum ...	111
,, mollugo ... 111,	119
,, palustris ... 30,	111
,, saxatile	111
,, uliginosum ...	111
,, verum 30, 111,	119
Genista anglica	87
,, tinctoria	87
Gentiana acaulis	116
Geranium dissectum ...	76
,, molle	78

	Page
Gesanium phaeum ...	18
,, pratense 19, 78,	161
,, robertianum ...	17
,, rotundifolium...	78
,, sanguineum ...	78
,, silvaticum 19, 78,	161
,, striatum ...	89
Geraniaceae	26
Gladiolus communis ...	205
Glaux maritima ... 84,	168
Glechoma hederacea ...	112
Glyceria aquatica 147, 192,	193
,, fluitans ... 192,	193
Goatsbeard	13
Gonolobia	23
Gooseberry ... 131,	132
Goutweed	20
Grapes	44
Grass	193
Groundsel	179
Gymnadenia conopsea ...	154
Hawthorn	172
Helianthus	18
Helianthus annus ...	102
Hepatica triloba	205
Helichrysum	21
Heliocarpus americanus	18
Hepatica	18
Heracleum sphondylium	121
Hieracium ... 21,	48
,, murorum ...	198
,, pilosella ...	103
,, vulgatum 103,	198
Hippuris vulgaris ...	84
Hop	41
Horse-radish	11
Houseleek	94
Holcus	146
,, lanatus 146, 147, 195,	196
,, mollis 146, 147, 164, 195,	196
Hordeum 49,	146
,, distichum ...	209
,, vulgare 148, 188, 198,	204
Hydrocotyle vulgaris ...	121
Hydrophyllaceae ...	25
Hypochaeris	21
,, glabra ...	103
,, radicata ...	103
Impatiens fulva 17, 18,	127
,, noli-me-tangere	127
Indian corn ... 16,	189
Inula helenium	180

	Page
Inula dystenterica ...	83
Iris	137
,, foetidissima ...	137
,, pseudacorus ...	137
Isopyrum	18
Jasione montana ...	180
Juncus acutus	83
,, bufonius ...	83, 199
,, compressus ...	163
,, gerardi	163
,, camprocarpus	83, 199
,, obtusifolius ...	83
,, squarrosus ...	199
,, uliginosus ...	199
Juniperus communis ...	172
,, sabina ...	171, 172
Kerguelen's Land cabbage	11
Knautia arvensis ...	191
Koeleria	146
,, cristata	153
Labiatae ...	24, 25, 42
Lactuca	21
,, muralis ...	104, 164
,, scariola, *var.* sativa	21
Lamium album	33
,, amplexicaule ...	33
,, maculatum ...	33
,, purpureum ...	33
,, rubrum ...	33
Lappa	163
Lapsana	21
,, communis	102, 104
Lathyrus angustifolia ...	87
,, macrorhizus ...	75
,, palustris ...	27
,, pratensis	33, 75, 87
,, silvestris ...	87
Leguminosae	24
Lemna arrhiza	9
,, gibba	9
,, minor	9
Leontodon ...	21, 105
Lepidium	8, 14
,, sativum... ...	11
Lettuce	21
Ligustrum vulgare ...	166
Lilium	208
Limnanthemum nymphoides	145
Linaceae	23
Linaria spuria	194
Linum catharticum ...	92
,, usitatissimum ...	92
Listera ovata ...	91, 154

	Page
Lithospermum	32
Lolium	146
,, perenne	147, 189, 196, 204
,, temulentum ...	189
Lonicera periclymenum ...	152
Lotus	31
,, corniculatus ...	87
Luzula campestris	140, 141
,, maxima	141
,, pilosa ...	140, 141
,, silvatica	140
Lychnis dioica	203
,, diurna	191
,, flos-cuculi ...	191
,, vespertina ...	191
Lycium barbatum ...	46
Lycopodium annotinum ...	8
Lycopodium cernuum ...	8
Lycopersicum esculentum	15
Lycopodium inundatum	8
Mahonia	146
,, aquifolia ...	45
Maianthemum bifolium ...	154
Mangold	81
Marsh marigold	208
Matricaria inodora ...	198
Medicago	31
,, falcata	76
,, lupulina ...	76
Medlar	172
Melampyrum arvense	153, 181
,, cristatum ...	153
Melilotus	13
,, officinalis ...	33
Melocactus	14
Mentha	113
Mercurialis perennis ...	52
Mespilus germanica ...	172
Meum athamanticum ...	21
Milium	146
,, effusum	165, 196
Molinia	146
,, caerulea ...	153
Mulgedium	21
Muscari racemosum	90, 204
Myrrhis odorata	120
Myosotis arvensis	32, 197
,, caespitosa ...	197
,, palustris ...	197
Narcissus poeticus ...	138
Nyctaginaceae	25
Oenothera	14
Onagraceae	25

	Page
Onobrychis	86
,, sativa ...	87
Ononis	31
,, spinosa ...	33, 87
Orchis incarnata	154
,, latifolia ...	91, 153, 154
,, maculata	91
,, militaris	154
,, morio	154
Origanum vulgare ...	113
Ornithogalum umbellatum	139
Orobus	31
,, tuberosus	33, 75
Oxyria reniformis	135, 191
Oxytropis	86
Paeonia officinalis ...	93
Palmaceae	26
Panicum	146
,, miliaceum ...	8
Papaver argemones ...	31
,, rheas ...	31, 197
,, somniferum ...	31
,, dubium	31, 197
Paris quadrifolia	154, 201 204
Pastinaca sativa ...	20, 84
Parnassia palustris ...	144
Pedicularis	10
,, silvatica ...	144
,, palustris	144, 181
Pellia epiphylla	8
Persica vulgaris	129
Petasites officinalis ...	180
Petroselinum sativum	20 122
Peucedanum	122
,, palustre ...	20
Phajus wallichii	170
Phalaris	16
,, arundinacea	146, 154, 192
Phaseolus vulgaris ...	76
Phillyrea latifolia ...	167
Phillyrea media	168
Phleum	49, 146
Pheum pratense	166, 196
Phragmites communis	155, 156, 157
,, vulgaris ...	166
Phytemna orbicu'are ...	86
,, spicatum ...	86
Pilewort	197
Pimpinella magna	20, 123
,, saxifragae	20, 123
Pinus cembro	93
,, insignis	179

	Page
Pinus lambertiana ...	93
,, maritima	179
,, montana	92
,, silvestris ...	92, 179
,, strobus ...	93, 179
Pisum	49
,, sativum ...	33, 75, 87
Plagiochila asplenioides ...	8
,, major ...	35, 160
Platanthera bifolia ...	35
Plantago lanceolata ...	154
,, chlorantha ...	154
Poa	49, 146
,, annua ...	85, 157
,, alpina	157
,, bulbosa	85
,, compressa ...	85, 157
,, nemoralis	157
,, pratensis	85, 157, 204
,, trivialis ...	85, 157
Polygonum amphibium ...	135
,, aviculare	82, 191
,, bistorta	136, 162, 193
,, convolvulus	135, 191
,, hydropiper	191, 200
,, lapathifolium	135, 191
,, mite	200
,, persicaria	135, 191, 200
,, vivipara	136, 162, 193, 200
Polypodium	8
,, dryopteris ...	95
Populus	52
,, alba ...	43, 92
,, balsamifera ...	43
,, canescens ...	92
,, nigra	51
,, tremula	43, 92
Portulaca cleracea ...	12
,, sativa	12
Portulacaceae	24
Potato	15
Potentilla anserina ...	207
,, argentea,	176, 207
,, fragariastrum	176, 207
,, tormentilla ...	176
Poterium sanguisorba	167, 176, 207
Prenanthis purpurea ...	105
Primulaceae	26
Primula farinosa ...	205

	Page
Primula officinalis	116
,, vulgaris	205
Pringlea antiscorbutica	11
Privet	166
Prunus	39, 43
,, avium	161
,, domestica	129, 161
,, persica	41
,, spinosa	129, 161
Psamma arenaria	193
Pyrethrum arvense	27
Pyrus	39, 52
,, aucuparia	172
,, communis	171
,, malus	39
,, vulgaris	172
Quercus pedunculata	169
Quince	172
Radish	11
Ragwort	179
Ranunculaceae	25, 26, 42
Ranunculus acris	34, 85, 150, 198
,, auricomus	34, 85, 161
,, bulbosus	34, 85, 91, 155, 198, 205
,, ficaria	34, 79, 85
,, flammula	34
,, repens	34, 85, 155, 197, 198, 205
,, sceleratus	197
Raphanus raphanistrum	11
Raspberry	175
Red currant	132
Rhamnus catharticus	129, 147
,, frangulae	146
Rheum officinale	156
Rhinanthus crista-galli	181
Rhodiola rosea	129
Rhubarb	156
Rhyncospora alba	188
,, fusca	188
Ribes grossularia	42, 46, 131, 132
,, nigrum	93, 132
,, rubrum	18, 42, 132
Riccia fluitans	9
Robinia	14
Rosa	34
,, alpina	175
,, arvensis	41, 174
,, canina	41, 174
,, centifolia	174
,, damascena	41
,, glauca	41
Rosaceae	25
Rudbeckia	18
Rubus bifrons	174
,, caesius	174, 207
,, discolor	174
,, fructicosa	169, 174, 207
,, hirtus	17
,, idaeus	175
,, thyrsoideus	174
Rumex acetosa	28, 82, 90, 136, 157, 194
,, acetosella	28, 82, 90, 136, 194
,, aquaticus	156
,, conglomeratus	82, 156
,, crispus	28, 82, 156
,, hydrolapathum	82, 156
,, maritimum	82, 156
,, obtusifolium	82, 156, 193
,, saxatiis	174, 175
Rye	196, 204
Sagina apetala	133
,, procumbens	133
Sagittaria sagittifolia	201
Salicornia herbacea	81
Salix alba	40
,, aurita	43, 51
,, capraea	43, 51
,, cinerea	43, 51
,, nigra	43
,, viminalis	40, 51
,, vitellina	51
Salpiglossis	14
Salsola kali	89
Salvia pratensis	33
Sanicula europaea	123
Sanguisorba eupatoria,	207
,, officinalis	177
Santalaceae	27
Saponaria officinalis	191, 203
Sarothamnus tinctorius	87
Saxifragaceae	25
Saxifraga aizoon	131
,, granulata	130
,, hostii	131
,, longifolia	131
,, mutata	131
,, stellaris	130
Scabiosa arvensis	27, 191
,, columbaria	191
,, succisa	191
Scarlet runner	76
Scilla bifolia	83, 192

	Page
Scilla nutans	83
Scirpus lacustris	145
,, maritimus ...	84
,, parvulus ...	194
,, tabernaemontana	145
Schizanthus	14
Scleranthus annuus ...	30
Scolopendrium vulgare ...	95
Scrophularia altaica ...	33
,, aquatica 33,	72
,, nodosa 33,	72
Scrophulariaceae ... 26,	42
Secale	146
,, cereale 148, 196,	204
Sedum rhodiola ...	129
Sempervivum	14
,, tectorum	94
Senecio ... 21, 163,	179
,, aquatica	106
,, jacobaea 106, 142,	179
,, palustris	179
,, silvatica ...	179
,, viscosa	179
,, vulgaris	179
Serratula tinctoria ...	163
Setaria	16
Shepherd's purse ...	11
Sherardia arvensis ...	30
Silaus pratensis	122
Silene	29
,, inflata 80, 134,	191
,, maritima ... 80,	191
,, nutans ... 134,	191
,, otites	191
Silphium	18
Silver fir	178
Sinapis	8
Sium latifolium ... 20,	84
Smyrnium olusatrum ...	124
Solanaceae...	23
Solanum 15,	48
Solanum tuberosum ...	15
Soldanella alpina ...	117
Solidago	18
,, virgaurea 86,	107
Sonchus	21
,, arvensis... 107,	180
,, asper	107
,, oleraceus 107,	180
Sorghum saccharatum ...	189
Sorrel	28
Spergula arvensis 8, 30,	131
Spergularia rubra 12, 30, 80,	134
Spinacea oleracea ...	32
Spiraea	39
Spiranthes	169
Stachys	48
,, palustris	33
Statice limonium	73
Stellaria graminea ...	191
,, graminea ...	191
,, holostea 133, 191,	203
,, media ... 30,	133
Stellaria uliginosa ...	133
Stipa pennata	193
Sueda fruticosa	89
,, maritima	89
Symphytum	32
,, officinale 149,	169
Tanacetum vulgare ...	108
Taraxacum	163
,, officinale ...	108
Tea tree	46
Teucrium scorodonium ...	114
Thalictrum ... 18,	158
,, alpinum ...	165
,, flavum 133,	158
,, minus 133, 158,	205
Thesium humifusum ...	137
Thymus	33
,, serpyllum ...	114
Todea	8
Tomato	15
Tragopogon	21
,, pratensis 13, 109,	190
Trientalis europaea ...	201
Trifolium	31
,, agrarium ...	76
,, arvensis ...	76
,, frangiferum ...	77
,, hybridum ...	77
,, medium ...	77
,, minor	76
,, ochroleucum ...	77
,, pratense 77,	88
,, procumbens ...	76
,, repens 8,	77
Triticum	146
,, caninum 148,	167
,, glaucum ...	158
,, junceum 158,	193
,, monococcum ...	195
,, repens 146, 148,	204
,, spelta ... 149,	195
,, vulgare 148, 149, 195, 196,	204
Trollius europaeus ...	162

	Page
Tropaeolum aduncum ...	169
Tulip	140
Tussilago farfara 52,	157, 180
Typha latifolia	192
,, minor	192
Ulmus campestris ...	43
,, montana	44
Urtica dioicaea ...	34, 141
,, pilulifera	141
,, urens ...	34, 141
Vaccinium	39
Valeriana dioica	72
,, officinalis 28,	72, 177
Valerianaceae	24
Verbascum blattaria ...	33
,, lychnitis ...	86
,, nigrum	33, 86
,, thapsiforme	33, 86
,, thapsus	33, 86
,, virgatum ...	33
Veronica alpina	112
,, anagallis	31, 160
,, arvensis... ...	31
,, beccabunga ...	31
,, hederaefolia ...	33
,, montana	112
,, scutellata ...	31
,, serpyllifolia ...	31
,, triphylla ...	31
Veronica verna	31
Vicia	49
,, cracca	33, 75, 88
,, hirsuta	33, 74, 88
,, sativa ...	33, 88
,, sepium ...	33, 75
,, sylvatica	46
,, tetrasperma	33
,, major	115
Vine	20
Viola	126
,, biflora	31
,, cornuta	126
,, hirta	205
,, lutea	126
,, odorata	205
,, palustris	127
,, silvatica	205
,, tricolor	31, 126, 205
,, tricolor, *var.* arvensis	23
,, riviana	31
Vitis	44
,, vinifera	20
Wallflower	11
Weymouth pine	93
Wheat	195, 196
Wolffia arrhiza	9
Zea mays ...	8, 16, 189
Zygophyllaceae	27

PLATE I

Fig.

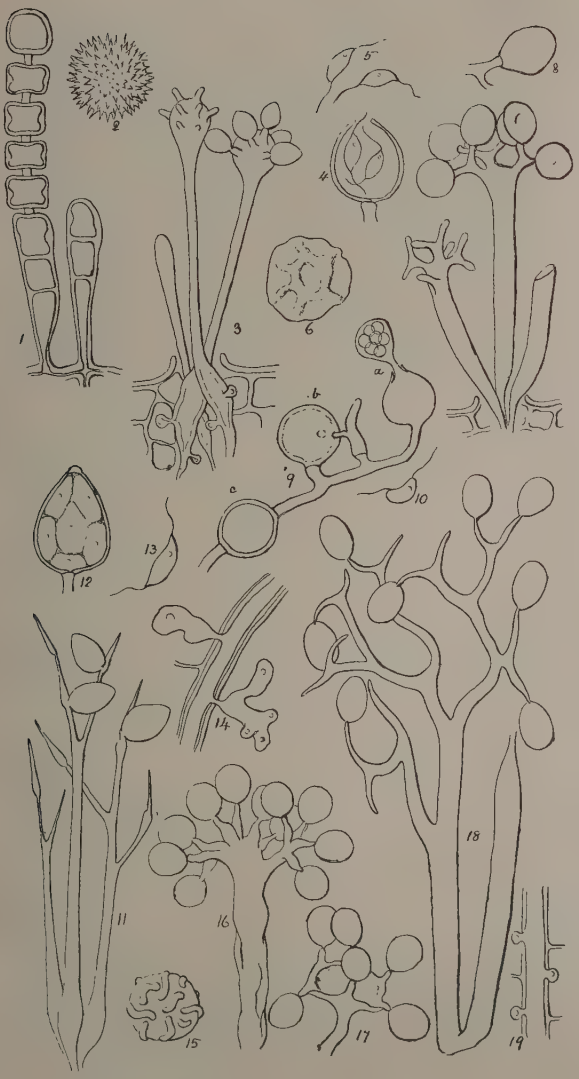
1. Conidia of *Cystopus tragopogonis*, Schroet.; mag.
2. Oospore of same; mag.
3. Conidial stage of *Basisiphora entospora*, Rose and Cobb; mag.
4. The same, showing the escape of zoospores from a sporidium or zoosporangium; mag.
5. Free zoospores of same; mag.
6. Oospore of same; mag.
7. *Plasmopara pygmaea*, Schroet.; conidial stage; mag.
8. Single conidium of same; mag.
9. *Pythium debaryanum*, Hesse; (a) conidium or zoosporangium liberating zoospores; (b) oosphere being fertilized by an antheridium; (c) chlamydospore or resting-spore; mag.
10. Free zoospore of same; mag.
11. *Phytophthora infestans*, De Bary, conidial stage; mag.
12. Conidium or zoosporangium of same; mag.
13. Free zoospore of same; mag.
14. Mycelium of same from tuber of a potato, haustoria are entering the cells from the mycelium running between the cell walls; mag.
15. Oospore of *Cystopus candidus*, Lev.; mag.
16. Conidial stage of *Sclerospora graminis*, Schroet.; mag.
17. *Pythium ferruc*, Regel, showing expanded tip of a branch of conidial stage bearing conidia; mag.
18. Conidial form of *Peronospora viticae*, De Bary; mag.
19. Mycelium of *Cystopus candidus*, Lev., giving off haustoria into the cells of the host-plant; mag.

PLATE I

Fig.

1. Conidia of *Cystopus tragopogonis*, Schroet; mag.
2. Oospore of same; mag.
3. Conidial stage of *Basidiophora entospora*, Roze and Cornu; mag.
4. The same, showing the escape of zoospores from a coridium or zoosporangium; mag.
5. Free zoospores of same; mag.
6. Oospore of same; mag.
7. *Plasmopara pygmaea*, Schroet; conidial stage; mag.
8. Single conidium of same; mag.
9. *Pythium debaryanum*, Hesse; (*a*) conidium or zoosporangium liberating zoospores; (*b*) oosphere being fertilised by an antheridium; (*c*) chlamydospore or resting-spore; mag.
10. Free zoospore of same; mag.
11. *Phytophthora infestans*, De Bary, conidial stage; mag.
12. Conidium or zoosporangium of same; mag.
13. Free zoospore of same; mag.
14. Mycelium of same from tuber of a potato, haustoria are entering the cells from the mycelium running between the cell walls; mag.
15. Oospore of *Cystopus candidus*, Lév.; mag.
16. Conidial stage of *Sclerospora graminis*, Schrœt.; mag.
17. *Bremia lactucae*, Regel, showing expanded tip of a branch of conidial stage bearing conidia; mag.
18. Conidial form of *Peronospora urticae*, De Bary; mag.
19. Mycelium of *Cystopus candidus*, Lév., giving off haustoria into the cells of the post-plant; mag.

Plate I



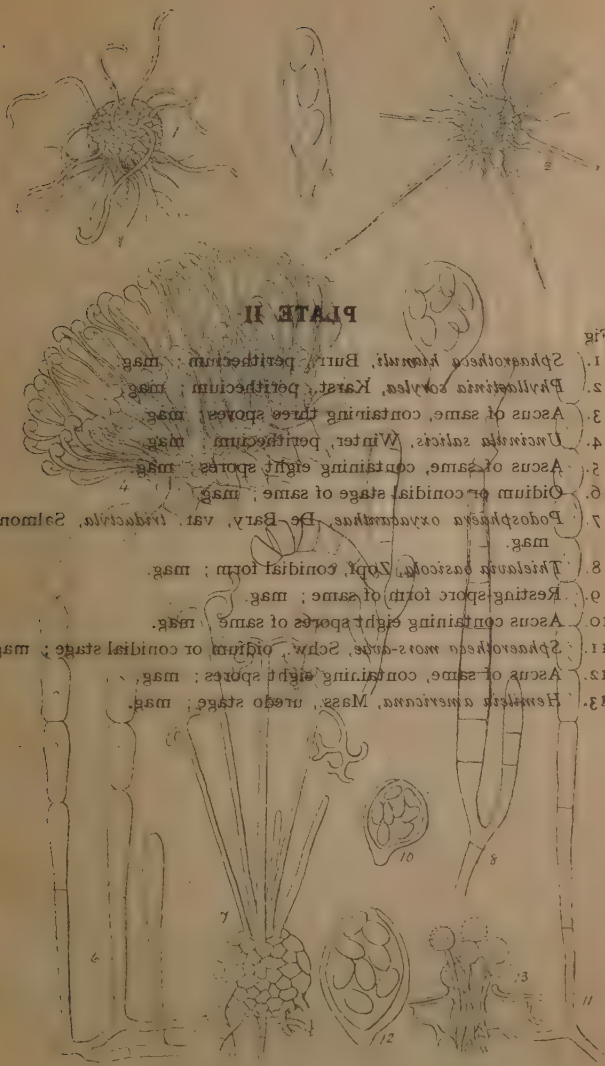


PLATE II

Fig.

1. Sphaerothèca hùmuli, Burr., perithecium ; mag.
2. Pyrillaetèria sorvìca, Karst., perithecium ; mag.
3. Ascus of same, containing three spores ; mag.
4. Uncinùla salìcis, Winter, perithecium ; mag.
5. Ascus of same, containing eight spores ; mag.
6. Oìdium or conidial stage of same ; mag.
7. Podosphæ̀ra oxyacanthæ, De Bary, var. tridactyla, Salmon ; mag.
8. Trichàurus fasciculàris, Zopf, conidial form ; mag.
9. Resting spore form of same ; mag.
10. Ascus containing eight spores of same ; mag.
11. Sphaerothèca mors-uvæ, Schw., oìdium or conidial stage ; mag.
12. Ascus of same, containing eight spores ; mag.
13. Hemìtrix americàna, Mass., uredo stage ; mag.

PLATE II

Fig

1. *Sphaerotheca humuli*, Burr., perithecium ; mag.
2. *Phyllactinia corylea*, Karst., perithecium ; mag.
3. Ascus of same, containing three spores ; mag.
4. *Uncinula salicis*, Winter, perithecium ; mag.
5. Ascus of same, containing eight spores ; mag.
6. Oidium or conidial stage of same ; mag.
7. *Podosphaera oxyacanthae*, De Bary, var. *tridactyla*, Salmon ; mag.
8. *Thielavia basicola*, Zopf, conidial form ; mag.
9. Resting-spore form of same ; mag.
10. Ascus containing eight spores of same , mag.
11. *Sphaerotheca mors-uvae*, Schw., oidium or conidial stage ; mag.
12. Ascus of same, containing eight spores ; mag.
13. *Hemileia americana*, Mass., uredo stage ; mag.

Plate II

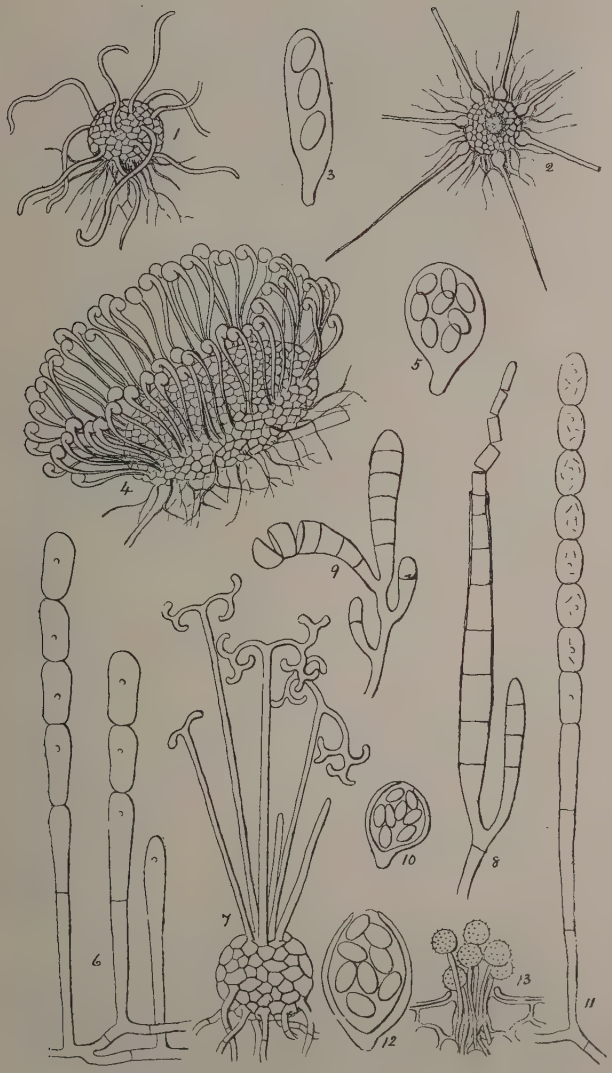


PLATE III

Fig.

1. Phragmidium rubi, Pers., teleutospore ; mag.
2. Triphragmium ulmariæ, Pers., teleutospore germinating and producing secondary spores ; mag.
3. Melasia polysporâ, *White*, teleutospores ; mag.
4. Puccinia prunî, Pers., teleutospore ; mag.
5. Mass of spores of same ; mag.
6. Cronartium ribicolum, Dietr., column of teleutospores &c. rounded at the base by uredospores ; mag.
7. Teleutospores of same, one germinating ; mag.
*7. Xenodochus carbonarius, Schl., teleutospore ; mag.
8. Rostrupia clavus, Lagerh., section through a sorus of teleutospores ; mag.
9. Teleutospore of same ; mag.
10. Uredospore of same ; mag.
11. Endophyllum sempervivi, Lév., teleutospore germinating ; mag.
12. Calyptospora goeppertiana, J. Kühn, ascigerous condition causing swellings on stems of cowberry ; somewhat reduced in size.
13. Teleutospores of same in epidermal cells of host-plant, some are germinating ; mag.
14. Aecidium stage of same, on leaves of silver fir ; about nat. size.
15. Aecidia of same ; mag.
16. Chain of aecidiospores of same ; mag.
17. Teleutospora of Dicæomyces labæ, Cooke.

PLATE III

Fig.

1. *Phragmidium rubi*, Pers., teleutospore ; mag.
2. *Triphragmium ulmariae*, Pers., teleutospore germinating and producing secondary spores ; mag.
3. *Milesia polypodii*, White, teleutospores ; mag.
4. *Puccinia pruni*, Pers., teleutospore ; mag.
5. Mesospore of same ; mag.
6. *Cronartium ribicolum*, Deitr., column of teleutospores surrounded at the base by uredospores ; mag.
7. Teleutospores of same, one germinating ; mag.

*7. *Xenodochus carbonarius*, Schl., teleutospore ; mag.

8. *Rostrupia elymi*, Lagerh., section through a sorus of teleutospores ; mag.
9. Teleutospore of same ; mag.
10. Uredospore of same ; mag.
11. *Endophyllum sempervivi*, Lév., teleutospore germinating ; mag.
12. *Calyptospora goeppertiana*, J. Kuhn, ascigerous condition causing swellings on stems of cowberry ; somewhat reduced in size.
13. Teleutospores of same in epidermal cells of host-plant, some are germinating ; mag.
14. Aecidium stage of same, on leaves of silver fir ; about nat. size.
15. Aecidia of same ; mag.
16. Chain of aecidiospores of same ; mag.
17. Teleutospore of *Uromyces fabae*, Cooke.

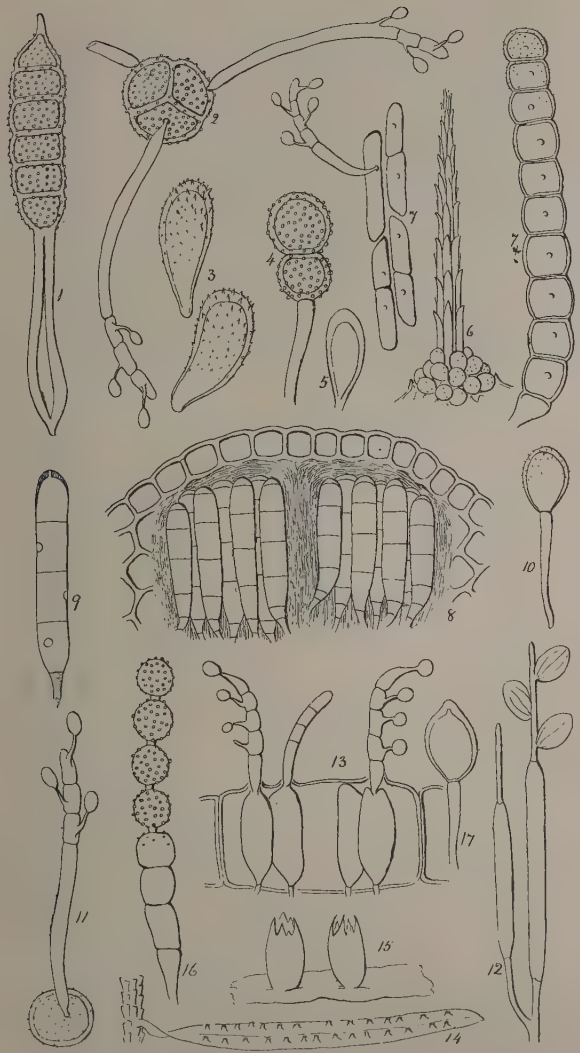

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PLATE IV

Fig.

1. *Melampsora paradoxa*, Rostrup; a chain of aecidiospores; mag.
2. Section through a sorus of teleutospores of same; mag.
3. Chain of aecidiospores of *Coleosporium senecionis*, Fries; mag.
4. *Gymnosporangium clavariaeforme*, Jacq.; aecidium condition; mag.
5. Aecidiospore of same; mag.
6. Thick-walled, dark coloured form of teleutospore of same; mag.
7. Thin-walled, pale coloured form of teleutospore of same; mag.
8. *Uredo sitis alnorum*, Pers.; spore-balls, one germinating; mag.
9. *Tallictia tritici*, Bjerk.; teleutospore germinating; mag.
10. Secondary spores of same, conjugating in pairs; mag.
11. *Thecaphora hyalina*, Ehrenb.; spore-ball, and two of its component spores; mag.
12. *Cintractia Pringlei*, Schroet.; section through teleutospore sorus; mag.
13. Teleutospore of same germinating; mag.
14. *Ustilago maydis*, Tul.; showing origin of spores within the walls of the hyphae; mag.
15. Spores of same, some germinating and producing a promycelium which becomes free from the spore, and then bears secondary spores; mag.

PLATE IV

Fig.

1. *Melampsora pinitorqua*, Rostrup, a chain of aecidiospores ; mag.
2. Section through a sorus of teleutospores of same ; mag.
3. Chain of aecidiospores of *Coleosporium senecionis*, Fries ; mag.
4. *Gymnosporangium clavariaeforme*, Jacq., aecidium condition ; mag.
5. Aecidiospore of same ; mag.
6. Thick-walled, dark coloured form of teleutospore of same : mag.
7. Thin-walled, pale coloured form of teleutospore of same ; mag.
8. *Urocystis anemones*, Pers., spore-balls, one germinating ; mag.
9. *Tilletia tritici*, Bjerk., teleutospore germinating ; mag.
10. Secondary spores of same, conjugating in pairs ; mag.
11. *Thecaphora hyalina*, Fingerh., spore-ball, and two of its component spores free ; mag.
12. *Chrysomyxa pyrolae*, Schroet., section through teleutospore sorus ; mag.
13. Teleutospore of same germinating ; mag.
14. *Ustilago vaillantii*, Tul., showing origin of spores within the walls of the hyphae ; mag.
15. Spores of same, some germinating and producing a promycelium which becomes free from the spore, and then bears secondary spores ; mag.

Plate IV

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